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Punching Press.

We illustrate on this page a new punching press made by the Fox Machine Co., Grand Rapids, Mich. As will be perceived, the machine conforms to the general practice in its principal features of design, and emphasis is put by the builders upon the fact that plenty of iron is put into it in those parts of the frame that must resist stress, while the legs which do nothing but hold the machine up, are simply made strong enough for this duty.

The machine is worked in the usual manner by a foot-treadle, and there is an eccentric adjustment of the height of the slide.

The stroke is $1\frac{3}{16}''$, but can be made anything from 1″ to 2″. Opening in bed, 8″x 9″; depth of throat from center of slide, $8\frac{1}{2}''$; extreme distance from bed to bottom of slide, $8\frac{1}{2}''$; adjustment of slide, $1\frac{1}{4}''$; fly-wheel, 30″x$4\frac{3}{4}''$; weight of fly-wheel, 440 pounds.

The press is designed to run at a speed of 150 turns, occupies 28″x36″ floor space, and weighs 2,000 pounds.

PUNCHING PRESS.

The Safety Element in Fly-wheel Construction.

By PROF. JOSEPH TORREY.

Attention has been called a number of times to the large number of recent accidents from bursting fly-wheels. Said accidents have certainly stimulated writing on the subject of fly-wheel construction, and during the last two or three years quite a number of publications have appeared on the above subject. On one subject nothing has been written for the excellent reason that no one feels like attempting the task —namely, the internal strains in large and irregularly shaped castings. So far as I know there is only the vaguest and most meagre literature afloat on this topic, and the idea of approaching it from a theoretical standpoint seems, at first sight, enough to turn an engineer's hair white. Let any one stand and watch the antics of a freshly rolled steel rail during the process of cooling on the bed, or let him heat an ounce of sheet-iron and an ounce piece of half-inch Norway iron, red hot, lay them one on the other and keep track of the rate of cooling. There are plenty more such experiments, but I think these two will give abundant food for thought. Then let him imagine a twenty-ton fly-wheel, with its massive hub, comparatively slender arms and rim, which may be either massive or wide and thin, with plenty of cooling surface. Let him remember that all these are going to cool at different rates, and that one will always be ahead of the rest, cool first and become rigid first. It will then appear that no such shaped mass can cool without developing internal strains of greater or less magnitude. In some cases they must be serious ones. The subject, as previously intimated, is an extremely difficult one to deal with, but at the same time it is not wholly beyond the reach of experiment and study. It is a simple physical matter and is governed by the same laws as prevail everywhere. The rate of cooling must depend largely upon the amount of the piece that is exposed to the air. In a large massive piece most of it is *inside*. In the same weight of sheet iron most of it is *outside*, and it would be expected, accordingly, that a pound of sheet iron would cool more rapidly than a pound ball of iron, an expectation which experience confirms. Of course, any experiments made in this direction would have to be rather rough ones, but I think it would be very interesting if some one would make some experiments on the rate of cooling of various-shaped pieces. For instance, a number of pieces of the same weight might be made of very different shapes, and these shapes could be chosen so as to be representative of the most common forms which turn up in castings. They could be tried, both by themselves and in contact with each other. Or, in the particular case of fly-wheels, small wheels might be cast and the rate of cooling of the different parts noted.

This knowledge might be utilized by managing so that the quick cooling parts should be held back a little and the slow cooling hurried up, by either burying in sand or scraping away the sand, according to circumstances. This may have been all done long ago. If it has I have no doubt we shall hear of it, and as for the general facts as I have stated them they are, of course, familiar to all who have had anything to do with castings.

But the real question is, it seems to me, is this the real difficulty? We know that we must count on internally strained wheels, so we allow a large factor of safety which is really nothing but a few hundred per cent. added to cover up what we do not know. My own belief is that fly-wheels are, in the main, designed on correct and sound principles now, and that they are generally run within reasonable limits of rim speed. This is not altogether ungrounded opinion. It is a matter which I have been watching for two or three years and on which I have made many direct observations. Moreover, I believe it is a very rare thing for a fly-wheel to burst except under circumstances where the speed of the engine was accidentally accelerated. If it be said that wheels should be made strong enough to stand emergencies the answer is that it is impossible so long as we use cast-iron to make our wheel. We can rely on a certain tensile strength and no more and, as I have pointed out in a previous paper, it makes no difference how much iron you put in the rim. Every pound adds just as much to the strain as it adds in holding power. More strength is practically out of the question. If the whole subject of casting large wheels were made the subject of exhaustive study and experiment, and if some way could be found of making cast iron stronger without spoiling it in other ways, and if great care were taken to avoid strains on cooling, we might gain a little but it would be inadequate.

As instances of fly-wheel accidents, which I believe to be pretty fair averages, I will instance three cases taken from my notes:

The first was in a town not far from Boston where the fly-wheel of an engine driving dynamos through a countershaft burst with disastrous effect. A fire in the wire tower caused a short circuit. The sudden strain on the main belt caused it to flap. The engine faced away from the dynamos, so that the belt passed backward near the governor balls. In one of its mighty flaps it struck the governor and broke it. As a natural result the engine speeded up and the fly-wheel burst within a very few seconds. In the second case, which was in a Western town, a wheel 12 feet in diameter and 25 inches face burst. The engine was driving a roll train and the governor belt came off. Before anything could be done there was the inevitable explosion. In the third case the massive thirty-foot balance wheel of a rolling-mill engine burst under the same circumstances. The governor belt came off and the engine ran away. I cannot find in all my notes nor do I remember seeing any account of a fly-wheel bursting under the ordinary running conditions. In some cases engines are undoubtedly running too fast. I know some where the speed of rim is as high as 110 feet per second, which is rather faster than is prudent, but in most cases the speed is not excessive.

Built up fly-wheels are undoubtedly better than those cast whole or in halves, in that they are freer from internal strain, and when their detail is good they must be considered as a distinct advance in engineering constructive art, but they are cast-iron, and as such will stand no trifling, and I do not see that they can be assigned any higher rim velocity than the ordinary form; nor are they proof against such accidents as I have instanced. In fact it is worth noticing that some of the most conspicuous fly-wheel accidents of recent times have been indulged in by built-up wheels constructed by no less a firm than the Corliss Steam Engine Co., all of which means, as I have said before, that so long as we make cast-iron wheels we are bound to have a wheel explosion whenever the engine speeds up much beyond its normal speed.

Now the best place for the ounce of prevention would be in safety devices by which if any accident occurs, tending to cause speeding up, the throttle shall be closed. I saw such a device on one large rolling-mill

engine about eight years ago. Perhaps they are more common now. I have not had much opportunity to see. In ordinary establishments they certainly are not common. I know that many engines have their governors so adjusted or so constructed that in such a case the engine shall stop; but in many cases there is no provision for such a thing as the breaking of a governor belt or of the governor itself. The device I saw was independent of the regular governor and consisted of an independent throttle operated by a weighted lever which I believe was connected by a wire with the regular governor—not the best arrangement by any means. I have no sketch to refer to and do not remember the details. Such a device well designed ought to be just as much a part of every engine (particularly those which carry large fly-wheels) as the safety valve is of every boiler, and it ought to be kept operative and in order with the same care. When this is done we shall hear of fewer fly-wheel accidents. So long as it is not done they will probably turn up with the same regularity that they have of late years.

Much has been written about various strains in fly-wheels and attempt has been made to show that in some cases these strains were responsible for the break. Unquestionably when a wheel gets ready to explode it will break where it is the weakest, and it is fortunately true that most things which burst have some weak point. For instance, I once had occasion to be thankful that a glass tube, containing. a certain antic substance, and which exploded within a foot of my face, was notably weaker at the other end than at the end toward me, but interesting as such studies may be from a theoretical point of view, I question whether they are competent witnesses when the question why fly-wheels explode is on the docket. Sometimes it has apparently been the case that the iron was of bad quality. Whenever this can be shown beyond doubt it is, of course, worth noticing, but conclusions as to the quality of cast-iron, as shown by the fracture of a casting, are to be taken with numerous grains of salt.

In a recent note the fly-wheel accident was set over against the boiler explosion and the statement was made by your correspondent that if the fly-wheel problem should be taken up in the same way that the boiler problem has been, there would be fewer such accidents. There is a certain parallelism between the two cases, but the fly-wheel is much the simpler one. In spite of all that can be said about the influence of mysterious internal strains and hidden causes the trouble generally is that the engine runs away, and this is the place to put the remedy.

The Catenary, the Parabola and the Circle.

BY FREDERIC R. HONEY.

The catenary is the curve assumed by a perfectly flexible cord $a\ b\ c$, Fig. 1, when its ends are fastened at two points a and c, the weight of a unit length being constant.

Since the draftsman is sometimes required to draw this curve, I propose to indicate a simple method which, within certain limits, is accurate enough for practical purposes.

I will begin by explaining the construction of the catenary, in order that we may have an opportunity of comparing the approximation to the true curve.

The derivation of the equation of the catenary is explained in the higher mechanics*.

It is $y = \frac{a}{2}\left[e^{\frac{x}{a}} + e^{-\frac{x}{a}}\right]$ in which e is the base of the Naperian or hyperbolic system of logarithms.

To Plot the Catenary.—Let o, Fig. 2, be the origin of co-ordinates. Assigning to a any value as 3, the equation becomes,

$$y = \frac{3}{2}\left[e^{\frac{x}{3}} + e^{-\frac{x}{3}}\right]$$

* See Bowser's Analytic Mechanics, p 221, et seq.

To find the lowest point of the curve,

Put $x = 0 \therefore y = \frac{3}{2}\left[e^{0} + e^{-0}\right]$

$= \frac{3}{2}\left[1 + 1\right] = 3.$

Then put $x = 1 \therefore y = \frac{3}{2}\left[e^{\frac{1}{3}} + e^{-\frac{1}{3}}\right]$

$= \frac{3}{2}\left[1.396 + 0.717\right] = 3.17$

Put $x = 2 \therefore y = \frac{3}{2}\left[e^{\frac{2}{3}} + e^{-\frac{2}{3}}\right]$

$= \frac{3}{2}\left[1.948 + 0.513\right] = 3.69.$

Put $x = 3, 4, 5$, etc., etc., and find the corresponding values of y. For each value of y we obtain two symmetrical points, as for example, o and o^1.

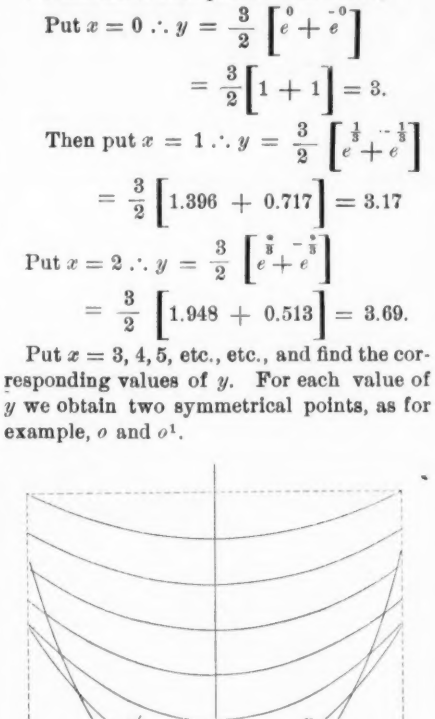


Fig. 2

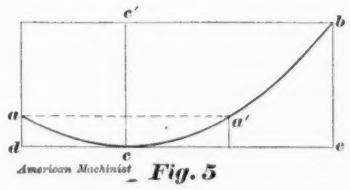


Fig. 5

In this way by making a successively equal to 2, 3, 4, 5, 6, 7 and 8, the curves of Fig. 2 were plotted.

In each case we find that the distance from the origin to the lowest point of the curve is equal to a; for putting $x = o$, the general equation becomes,

$$y = \frac{a}{2}\left[e^{0} + e^{-0}\right] = \frac{a}{2}\left[1 + 1\right] = a.$$

In Fig. 3 I have arranged the curves in such a way that the points having the same abscissa ($x = 4$) are brought together. This figure affords an illustration of seven cords of different length suspended from the common points a and b. My object in drawing so many curves is to indicate to the draftsman the limits within which an approximation may be made. Within certain limits the parabola approaches so nearly to the catenary, that in practice the former may be accepted as a representation of the true curve. The broken line represents the parabola in each case corresponding to the catenary having the vertex and two points a and b in common with it; and it will be observed that for $a = 6$, $a = 7$ and $a = 8$, the parabola apparently coincides with the catenary. If the drawing be made on a larger scale a slight divergence between the curves will be discovered. For $a = 4$ and $a = 5$ the deviation is not very great; and the draftsman may plot a parabola as a guide, being careful to draw the curve as indicated in the figure. For $a = 2$ and $a = 3$ the deviation is greater; but even in each of these cases the expert draftsman, with Fig. 3 as a model, will have little difficulty in drawing the catenary approximately with the aid of the parabola which accompanies it.

The broken and dotted line represents in each case an arc of a circle passing through the vertex and the extremities of the curve, the center being on the axis. We see that the circle deviates from the catenary far more than the parabola. An arc of a circle may, however, be drawn within narrow limits, which the draftsman will readily determine by an inspection of the figure. In the drawing the parabola, the catenary and the circle apparently coincide within the limit $a = 6$. If the drawing be made on a larger scale the deviation will, of course, be detected.

We have seen that the work in plotting a catenary occupies considerable time; and that it would be entirely out of the question to draw the curve in this way in practice; whereas the construction of a parabola is very simple.

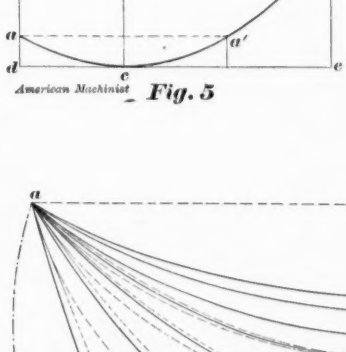


Fig. 3

TO PLOT A PARABOLA.*

Let the vertex a and the two points b and b', Fig. 4, be given. Complete the rectangle $b\ c\ c'\ b'$. To draw one-half of the curve, divide $a\ c$ and $b\ c$ into any number of equal parts—the same number in each case. From 1, 2 and 3 on $a\ c$ draw lines parallel to $c\ b$. Join a with each of the points 1, 2 and 3 on $b\ c$. The curve is traced through the points of intersection as illustrated, and the other half of the parabola is constructed in precisely the same manner.

* A similar method of plotting all the conic sections, including the circle, the ellipse, and the hyperbola, is explained in Warren's "Stone Cutting," p. 14, et seq.

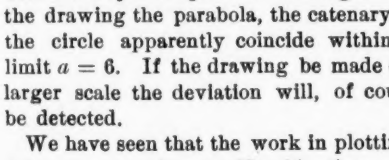


Fig. 4

Fig. 1

The most general form which the problem can assume is: *To draw a catenary when the extremities of the cord are not on the same level.*

Let a and b, Fig. 5, be the extremities of the curve, the lowest point of which must be on the level indicated by the line $d\ e$. Assuming that a parabola will represent the catenary, the problem is resolved into drawing a parabola through the points a and b, and tangent to $d\ e$.

In order to determine the position of c, we proceed as follows: The equation of the parabola is $x^2 = a\ y$. In Fig. 5 the ordinate $e\ b$ is four times the length of $d\ a$.

Calling the abscissa $c\ e = x_1$,
Calling the ordinate $e\ b = y_1$,
Calling the abscissa $c\ d = x_2$,
Calling the ordinate $d\ a = y_2$.

We may write the equations:

$$x_1^2 = a\ y_1 \qquad (1)$$
$$x_2^2 = a\ y_2 \qquad (2)$$

Divide Equation (1) by (2) and we have:

$$\frac{x_1^2}{x_2^2} = \frac{y_1}{y_2} = \frac{4}{1}.$$

Extract the square root of both sides of this equation,

$$\therefore \frac{x_1}{x_2} = \frac{2}{1}.$$

From this we see that the line $d\ e$ must be divided into three equal parts in order to locate c, *i. e.*, in order that we may have the proportion:

$$c\ e\ (= x_1) : c\ d\ (= x_2) : : 2 : 1.$$

Having found c, which is the vertex of the parabola, the part of the curve $c\ a'\ b$ is constructed in precisely the same way as $a\ b$ in Fig. 4. The remainder of the curve $c\ a$ is drawn in the same manner as the corresponding part of the curve in Fig. 4, the parts $c\ a$ and $c\ a'$ being symmetrical with respect to $c\ c'$.

Mechanically Propelled Lifeboats.

It may be remembered that about two years ago the National Lifeboat Institution placed on trial at Harwich the first mechanically-propelled boat intended for life-saving purposes. This vessel, named the "Duke of Northumberland," was constructed by Messrs. R. and H. Green, the widely-known shipbuilders of Blackwall, and engined by Messrs. Thornycroft, of Chiswick. She is 50 feet long, 12 foot beam, and her loaded displacement at 3 feet 6 inches draught is 23 tons. Her propelling machinery consists of a horizontal compound surface condensing engine of about 170 horse-power, driving a nearly horizontal turbine of 30 inches in diameter, which delivers its water through two outlets in the sides of the boat, and draws its supply through a vertical scoop-shaped inlet amidships. The boiler is one of Mr. Thornycroft's patent water-tube type with a heating surface of 606 square feet, and grate surface of 8½ square feet. This boat, after going through an exhaustive series of trials, making during one of them the passage from Harwich to Holyhead, a distance of 1,000 miles, without the least mishap, was eventually placed on the station at Harwich, and has since done excellent service in the saving of many lives and much valuable property. The success attained suggested the construction of two other boats by Messrs. Green, one for the Royal National Lifeboat Institution, and the other for the Lifeboat Institution of South Holland. These vessels have the following principal dimensions: Length, 53 feet; beam, 16 feet; depth, 5½ feet, and their loaded displacement is 30 tons, giving them a draught of 3 feet 3 inches, at which they will carry from 30 to 40 passengers, 4 tons of coal in the bunkers, and half a ton of fresh water in their reserve tanks. The first of them—or that intended for the Royal National Lifeboat Institution—launched some months ago, is nearly ready for her official trial; the second—that for the kindred institution in South Holland—was launched on Friday of last week. Instead of propulsion being dependent, as in the case of the "Duke of Northumberland," upon one turbine and inlet to feed it, the new vessel is fitted with two vertical centrifugal pumps placed on the starboard and port sides,

driven direct from the crank-shaft—to which they are coupled and co axial—of an inclined compound direct-action engine of 200 horse-power. For forward and backward motion, go-ahead and go-astern, outlets—the former in the bottom and the latter in the sides of the vessel—are connected by pipes to each of the pumps, and to give a lateral propulsion to the boat a special side outlet has been arranged—which has been patented by Mr. J. F. Green both in England and abroad—the advantage of which when maneuvering round a wreck is considered invaluable, as the water can be discharged through the outlet nearest the wreck, and thus act as a buffer or fender in keeping the boat and the wreck from colliding, and assisting it by sideways propulsion in getting clear away when desirable. The buoyancy of the new vessel has been very carefully considered, and to add to her safety she is divided into no less than 13 water-tight compartments, but should one of these be stove in provision is made to connect it with the centrifugal pump inlets in such a way that the inflow of water would be utilized for the boat's propulsion. The boiler for supplying steam to the compound engine of the vessel is of the water-tube type, and will, together with the whole of the propelling machinery, be fitted by Messrs. John Penn & Sons, of Greenwich. It is expected that the official trial of the first of the improved type of steam lifeboats will shortly take place.—*Engineering.*

Mr. Edward J. Willis, whose articles in the AMERICAN MACHINIST in relation to the performance of steam engine indicators under different conditions have attracted wide attention, has accepted the position of General Manager of the Talbott Machine Works, of Richmond, Va. These works have been recently reorganized, and are to be operated by a stock company.

Some New Emery Wheels.

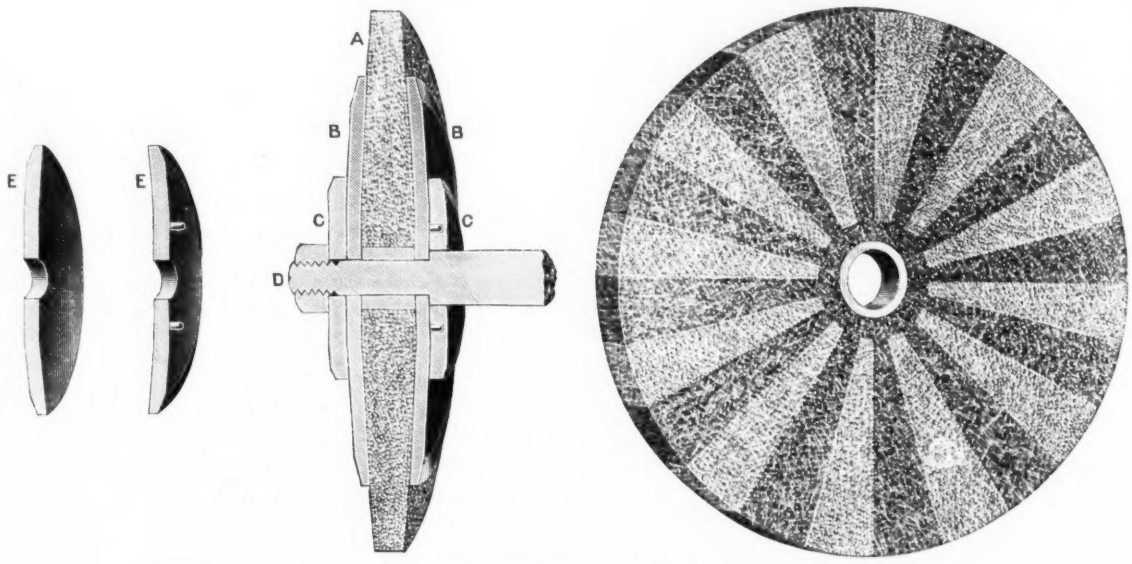
The illustrations presented herewith will serve to give an idea of two new features applied to emery wheel manufacture, by the Safety Emery Wheel Co., Springfield, Ohio. The first of these is a device designed to enable wheels to be run at a speed which will give them their highest efficiency, and yet provide a safeguard against bursting. This is accomplished by making the sides of the wheel convex, as shown in the section, and providing safety collars which are correspondingly formed, both sides of the wheel and all parts of the collars being turned true, and of such form that when tightened upon the arbor, slightly heavier pressure is secured between collars and wheel at the outer edge of the collars than elsewhere, thus insuring that even should the wheel burst in service—which is claimed to be almost an impossibility—the pieces cannot fly, but are held securely by the collars. To test this matter a wheel made in this form, 18″ diameter, 2½″ face, was broken in three pieces, then mounted upon an arbor, and run at a speed of 10,000 revolutions (about nine times the usual emery wheel speed), and none of the pieces flew out of place.

The makers of this wheel, who are experienced emery wheel men, claim that the efficiency of an emery wheel is increased by running it at high speed, or, as they put it, a wheel will do more grinding in two revolutions than in one revolution, and that it is therefore usually desirable to run them at the highest safe speed; a limit, which by this device is raised materially above the standard of 5,000 to 5,500 feet peripheral speed per minute, with yet greater safety.

From two to three different sized pairs of collars are used with each wheel, the larger ones being used when the wheel is new, and the smaller ones as it wears down, thus keeping the outer diameter of the collars near the periphery of the wheel at all times.

Where for any reason it is necessary that one side of the wheel should be flat, they can be so made.

One of the safety collars has two pins which engage with holes drilled in the fast collar of the spindle for that purpose, there being extra holes in the safety collar to serve as a template in drilling for the pins. Collars are made of drop-forged steel.



SOME NEW EMERY WHEELS.

The second illustration is of a wheel composed of equal sections of emery and corundum.

It has been found that for many purposes a wheel which is scored deeply across the face is greatly improved in cutting qualities, cutting faster and with much less liability to glaze and heat the work. This wheel, composed of alternate sections of emery and corundum seems to attain the same end without the objectionable features, the corundum being more brittle and giving what is virtually a softer section with the same mixture of "bond." Without at this time attempting to theorize upon this, it is sufficient to say that trial has seemed to prove the advantage of this plan for certain kinds of grinding which includes cylindrical grinding (internal and external), and for surface grinding with regular surface grinding machines, they have been shown to possess exceptional value.

Instead of sheathing the hulls of iron and steel vessels it is proposed to put a copper coating on the hulls by means of electricity. The plating is to be done in sections by means of a bath contained in a rectangular box opened at one side and fitted water-tight to the skin of the ship. It is said that the joints of these sections can be united so perfectly by the electro-plating process that the whole coating of the vessel becomes an unbroken metallic sheet. It is claimed that experiments have shown that the copper can be deposited perfectly over the hull, and that it will cling with such tenacity to the steel as to make its removal impossible without destroying it.

A Rule for Laying out Driver Brakes of the Cam or "Spread" Variety.

BY WILLIAM H. FORD.

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Lay out wheels and frame as shown in diagram, $X\ X$ being the vertical center line between the wheels. Draw brake head in position with face of shoe described from a center 1½ inches below that of wheel center. It is perhaps unnecessary to say that the radius of shoe should be the same as the radius of wheel tread. Dropping the center as above will allow the proper slack $S\ S$ for almost every design of locomotive used in this country, and for every height of shoe above the track.

Any fixed distance, as is usually given for slack, say, ½ inch between shoe and wheel, is arbitrary, and may cause trouble if the shoes are hung low down as is absolutely necessary in some cases.

As to the proportion of power to weight on drivers, the great difference of opinion of the "many men of many minds," will determine that. Having so determined, divide the amount by four to get the pressure upon one shoe at B. Then having proportioned the lever $A\ B\ C$ at convenience, determine the horizontal force required at C by multiplying force at B by distance $A\ B$ and dividing by distance $A\ C$.

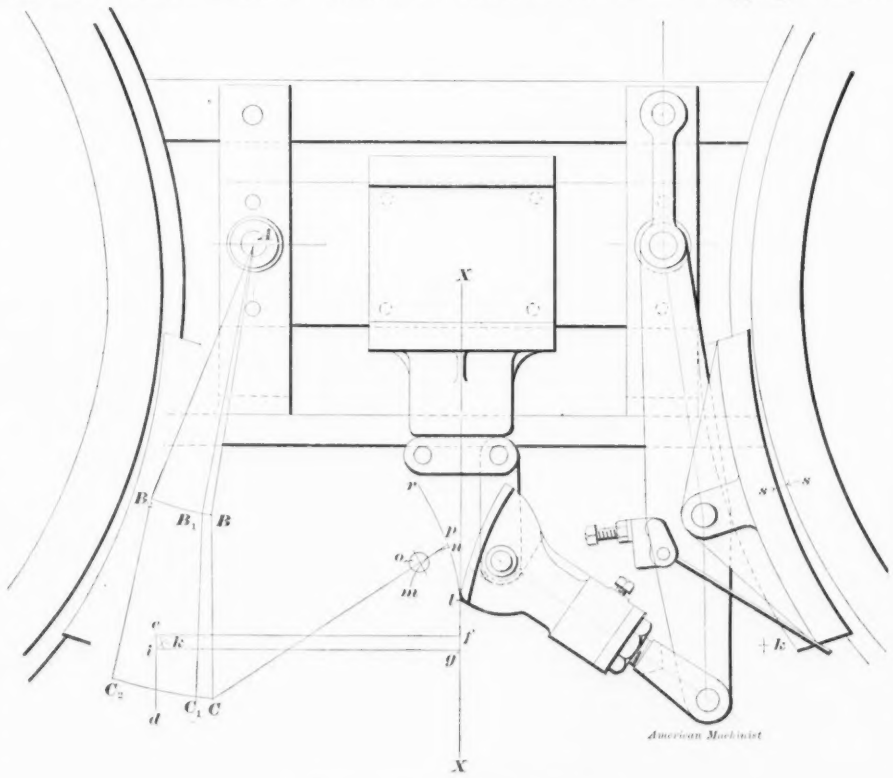
With A as center and $A\ B$ and $A\ C$ as radii, draw the arcs $B\ B_2$ and $C\ C_2$. The lengths of these arcs to be such as the lever would swing to allow a maximum wear of shoe and tire, including the slack $B\ B_1$; $C\ C_1$ being the swing due to the slack at the lower end of the lever.

Bisect the horizontal distance between C_1 and C_2 by the line $d\ e$. Next multiply power of the cylinder by the distance between C_1 and line X minus one-half the distance between centers of crosshead, and divide by twice the force on C. Set off this distance vertically above C_1 on line $d\ e$ at e. Draw $e\ f$ horizontal. With center in e and $e\ f$ as radius, draw arc $f\ g$. With $C_1\ e$ as radius and C as center, draw arc $i\ k$. From i draw a horizontal cutting arc $f\ g$ in g. With $C_1\ g$ as radius and C as center, cut $X\ X$ in l which is the point of contact of cam heels in released position.

With l as center and any convenient radius, usually 3 inches (distance from bottom or heel of cam to center of link pin o), draw arc $m\ n$, and from C tangent to this arc, draw $C\ p$.

With radius $e\ f$ and center in l cut arc $i\ k$ in k. This point k is the center of curve $l\ r$ for face of cam *in position of release.*

The center of link pin o is to be on line $C\ p$ at a convenient distance from face of cam, usually 1¾ inches. This rule does not give a constant force upon the shoes for all positions and extensions of the cams, for it is an impossibility to design a curve that will do so. However, it will give an approximation within 10 per cent. of the desired force. In most cases it will be found to come within 5 per cent.



LAYING OUT DRIVER BRAKES.

Increased Use of Gas Engines in Germany.

One of the principal economies introduced of recent years into Germany is the substitution of gas for steam engines in the smaller kinds of manufactures, where the motive power required does not exceed from 75 to 100 horse-power. At the Frankfort Exhibition of 1891 most of the dynamos were driven by gas and caloric engines, the display of which to the general public was almost as varied and interesting as that of the electrical apparatus to which they were attached. There were in use at that time throughout Germany about 18,000 gas engines, with an aggregate motive force of 60,000 horse-power. Since then the gradual cheapening of the cost of gas, and the rapid extension of electric lighting and electrolysis, have increased very speedily the use of gas engines, the economy and effectiveness of which were proved at the Frankfort Exhibition, and it may be fairly inferred that the number of gas engines in use throughout Germany is between 24,000 and 25,000. The progress made in improving both gas engines and their economical use is remarkable. The first gas engines, exhibited and used experimentally about 1868, were fatally extravagant. The Lenoir engine, which was the best model known to Germany, used 1,235 cubic feet of gas per horse-power per hour, whereas the engines now in use consume only 28 cubic feet per horse-power per hour in small sizes, and 23⅜ cubic feet in large sizes; so that 21⅛ cubic feet of gas per hour is sufficient for an incandescent lamp of 16 candle-power, and this proportion is said to have been reduced in large plants which employ engines of 500 horse-power and upwards to 17⅜ cubic feet of gas per horse-power per hour. The United States Consul-General at

Frankfort, in giving a tabular statement of the cost of gas in twenty-four principal German cities, observes: "How economical such a motive power must be for all the smaller forms of manufacture, and especially for electric lighting by isolated plants, is apparent, the cost of gas ranging from 3s. 11½d. at Bochum to 6s. at Altona, Bremen and Mayence, and averaging 5s. per 1,000 cubic feet. In Frankfort, where the price is 4s. 5½d. per 1,000 cubic feet, there are two companies, one English and the other German, with parallel mains under all the principal streets, who supply gas of uniformly excellent quality. When it is considered that coal for the manufacture of gas in Frankfort is brought from England and the Ruhr district of Westphalia, it will be apparent that for two rival companies to prosper in a city containing 180,000 inhabitants by selling gas at 4s. 5½d. per 1,000 cubic feet, there must be both good management and the employment of the most improved methods. The cheapness of gas everywhere in Germany is the direct result of the care and skill with which the residual products of coal distillation, ammonia, tar, etc., are saved and utilized."—*The Engineer* (London).

Compound Air Compression and Intercooling.

By Frank Richards.

In the American Machinist, December 4th, I exhibited some indicator cards from a pair of tandem connected, single-acting compound air cylinders compressing air to 70 pounds gauge, and I called attention to the unequal apportionment of the net resistance to the alternate strokes. At 70 pounds pressure it appeared that there was about two and one-half times as much work upon one stroke as upon the other. I venture to reproduce a pair of those cards here to show graphically how the net resistance is distributed throughout each stroke. When the compressor is in operation the near sides of both pistons are always exposed to the atmospheric pressure. The compressing side of the larger piston is exposed to the atmospheric pressure, or nearly so, during its intake stroke. The working side of the smaller piston is never exposed to the atmospheric pressure. During the intake stroke of the smaller piston it is subject to the pressure due to the compression in the larger cylinder. As both of the pistons are upon one rod, whatever pressure there may be upon the smaller piston when the larger piston is doing its work is just so much help for the larger piston, and consequently *c b d e*, Fig. 2, is to be deducted from the total area of diagram *A*. In Fig. 3 the area *c b d e*, representing this reacting pressure, has been reduced to the scale corresponding to the size of the cylinder and superimposed upon diagram *A*. It will be seen that until the point *i* is reached the steam cylinder, or whatever motor is employed, has "less than nothing" to do, and if the compressor were running slowly it would be apt to give a perceptible jump ahead when it went over the center. In Fig. 4 the two diagrams have been combined into a single figure with *A B* as the line of no resistance. This it will be remembered represents the distribution of the resistance for the compression stroke of the larger piston. Fig. 5 represents the resistance for the return stroke, which is the delivery stroke of the smaller piston. This diagram is the same as *a b d e*, Fig. 2, but drawn to the scale of the larger cylinder. It has also for convenience been reversed. If the compressor were delivering the air at 35 pounds pressure, instead of at 70 pounds, the upper line of the diagram would approximately follow the dotted line *b a*.

As Figs. 4 and 5 represent the resistance for the alternate strokes of single acting cylinders, we may combine them, as is done in Fig. 6, and we then have the diagram for either stroke of tandem double-acting cylinders of the same sizes. This, of course, represents double the compression capacity of the single-acting cylinders.

Fig. 7 is a diagram of a double-acting, single compression cylinder of the same capacity, the assumed compression line being the mean of the adiabatic and the isothermal curves. The mean effective pressure of Fig. 7 is somewhat less than that of Fig. 6. This might have been expected because in the cylinders from which Fig. 6 was evolved the full benefits of water jacketing were not employed, the cylinder heads, for instance, not being jacketed.

We know tolerably well the importance of employing all available means of cooling the air while undergoing compression, and this may be a good time to look a little into the operation of a cooler, or, as it is commonly called, an "intercooler," placed between the cylinders of a tandem compound air compressor. It is assumed and asserted that by the use of the intercooler a complete cooling of the air, and of all the air, compressed by the first cylinder is effected before it is subjected to the second and final compression and delivery. I regret that I am not now able to present indicator cards

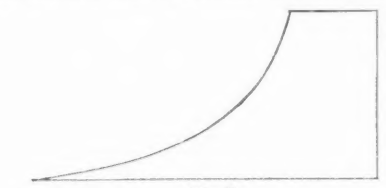


Fig.7

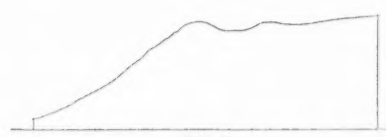


Fig.6

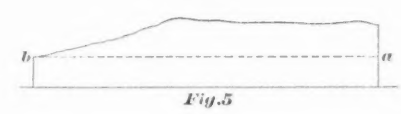


Fig.5

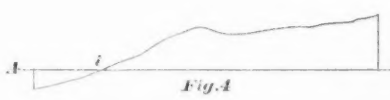


Fig.4

Fig.3

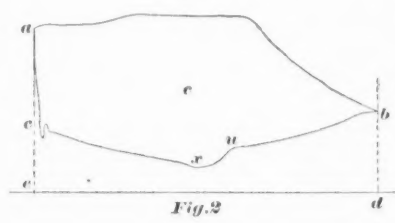


Fig.2

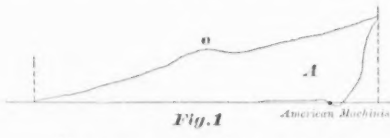


Fig.1

Compound Air Compression.

from a compressor of this type. I cannot learn that any actual cards from an American double acting tandem compound compressor with an intercooler have been published. For the satisfaction of my personal curiosity—I have no interest in any of the rival compressors—I am thinking of advertising for a set of steam and air cards from one of these compressors.

At the beginning of the operation of compression in a compressor of this type, remembering, as I have remarked elsewhere, that the function of the first cylinder is entirely one of compression, and that if either cylinder is to be called distinctively the "compressing" cylinder, it should be the first one rather than the second, the body of air to be acted upon by the first piston consists at the beginning of any stroke of the entire contents of the first cylinder and also of the air contained in the intercooler at the time and in the passages connecting the cooler with each cylinder. As the compressing piston advances in the first cylinder the total compression chamber at any time after the beginning of the stroke consists at that time of the remaining portion of the first cylinder still untraversed by its piston, of the intercooler and connecting passages as before, and of that portion of the second cylinder that has been vacated by its retreating piston. The actual situation is not quite as simple as our statement of it here, as we can see a little later. In standard compressors of the type that we are considering the piston areas and consequently the cubical capacity of the cylinders usually bear to each other about the ratio 10 : 4. Now, representing the capacity of the first cylinder by 10, that of the passage connecting it with the cooler by 2, of the cooler itself by 2, of the passage to the second cylinder by 2, and the total capacity of the second cylinder by 4, we may be able to see what the intercooler has to operate upon at any given time, and what chance it has to completely cool all the air. I assume, of course, that the cooler does thoroughly cool all the air that passes through it and at the pressure at which it passes through. I see no reason why it should not be made efficient in this respect.

The operation at successive stages of the compression stroke is as follows: At the beginning of the stroke the body of air to be compressed is represented by 16, comprised like this: The contents of first cylinder 10, passage to cooler 2, cooler itself 2, and the passage from the cooler to the second cylinder 2. Of this volume of air only 10 parts, the contents of the first cylinder, is "free air." The remainder, the contents of the cooler and the connecting passages, having been compressed upon the previous stroke to the pressure at which the air is finally delivered in the second cylinder, and at the end of the stroke having been shut off by itself apart from either cylinder, stands now at a pressure somewhat above 25 pounds gauge. As the stroke goes on, and the piston of the second cylinder recedes, this air in the cooler and passages begins to re-expand, and to flow into the second cylinder, and the pressure of this air consequently falls. At the same time compression is going on without cooling in the first cylinder. The total free air contents of the first cylinder are compressed independently until the middle of the stroke is reached, or a little beyond that, and a pressure of about 20 pounds without any of the cooling and power saving effects of the intercooler being felt upon it. Practically none of the air of any compression stroke flows through the cooler until after the middle of that stroke is reached. Assuming that the pressures in the compressing cylinder and in the cooler and passages become equal when the middle of the stroke is reached, and that at that point the piston of the first cylinder begins to act upon the whole body of air at once, the air under compression will then be: Contents of first cylinder 5, of passage to cooler 2, of cooler 2, of passage to second cylinder 2, and contents of second cylinder 3, total 13, and of this $\frac{4}{13} = .307$ has already passed the cooler and can be no more cooled by it, and $\frac{7}{13} = .538$ has not yet reached the cooler and has been compressed thus far without any cooling effect whatever from it. At three-quarter stroke the body of air under compression will be distributed as follows: Remaining contents of first cylinder 2.5, passage to cooler 2, cooler 2, passage to second cylinder 2, and contents of second cylinder 3, total 11.5, and of this body $\frac{5}{11.5} = .434$ has already passed the cooler and cannot be further affected by it, and $\frac{4.5}{11.5} = .39$ has not yet reached the cooler, and has not been cooled at all by it. When the end of the stroke is reached the air is distributed like this: First cylinder 0, passage 2, cooler 2, passage 2, second cylinder 4, total 10, and of this $\frac{2}{10} = .2$ has not yet reached the cooler and has undergone the whole compression from atmospheric pressure without cooling and all the contents of the second cylinder have been compressed and heated more or less after passing the cooler.

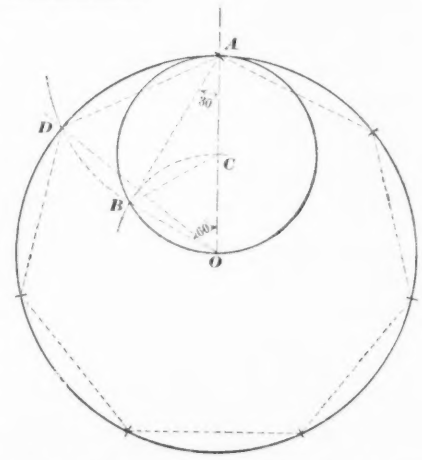
The intercooler applied in this way would seem to be a rather crude and not very efficient device; and when confidence in the virtues of the intercooler leads to the discarding of the most valuable feature of water jacketing, the jacketing of the cylinder heads, and when, for the same work of compression, two cylinders are used instead of one, with the consequent increase of friction in the machine, and with the increased friction also of the air past a double set of valves and through longer and more tortuous passages, it would surely seem to require a voluminous argument to show in the system any superiority over the single cylinder, water jacketed compressor. A set of indicator cards would be the convincing argument.

To Construct a Heptagon.

By S. H. Bunnell.

To inscribe in a circle of radius *O A* a heptagon, with a vertex at *A*.

On *A O* as a diameter draw a circle. From *O*, with *O C*, the radius of the circle *O B A*, as a radius, describe an arc cutting *O B A* in *B*. From *A* as a center, with radius *A B*, describe an arc cutting the large circle at *D*, and *A D* is a side of the required heptagon, which may be completed by laying off *A D* six more times on the circumference.



To determine the accuracy of this construction, the angle *D O A* may be calculated by trigonometry. *O B A* is a right-angled triangle, being inscribed in a semicircle. *O B C* is an equilateral triangle by construction, therefore the angle *B O A* contains 60 degrees, and the angle $B\,A\,O = 90° - < B\,O\,A = 30°$. Line $A\,B = O\,A\ cos.\ 30° = .866 \times O\,A$, and considering *O A* as unity *A B* = .866. By solving the triangle *O D A*, two of whose sides are unity, and the third .866, the angle at *O* is found to be 51° 20′.

The central angle of a heptagon is $\frac{1}{7} \times 360°$, or 51° 26′ nearly. The error is thus 6 minutes in 51° 26′, or 1 in 513, slightly less than .002.

By using a 30° triangle with which to draw the line *A B*, producing *A B* till it meets the large circle, and taking half of this line as the side of the heptagon, the construction is much simplified.

This method was discovered by Mr. A. L. Davison, valve designer of the Holly Manufacturing Company, of Lockport, N. Y., and so far as he knows, has never been described in print. Its simplicity and practical accuracy commend it for drafting purposes.

Explosion of a Water Tube.

One of the tubes of a water-tube boiler exploded in England recently, by which one person—the only one near the scene of the accident—lost his life. The matter is mainly of interest to engineers and boiler users because of the very plain reason for the accident. Of course, generally speaking, an explosion in a water-tube boiler is not so likely to be attended with disastrous consequences as in the instance of most other types of boilers, but in this instance the giving way of a 4-inch tube was a serious enough matter to cause loss of life. The fact is that the talk about absence of danger in the case of the giving way of a section of a water tube boiler should have no influence in the way of relaxation of vigilance on the part of those having such boilers in

charge, and none in the way of determining the kind of men employed to attend to them. Whether this accident was or was not due in any way to a false sense of security on the part of the engineer, we do not know. However, the tube gave way because it was permitted to become so incrusted with scale as to be burnt and weakened. At the investigation it was plainly brought out that there had been plenty of warning from tubes having previously failed, but without disastrous results. This being the case, and it being shown that the engineer did not give much attention to keeping the tubes clean, the only inference is that he was incompetent, through carelessness it would appear. At any rate this is one more illustration of the necessity of having good men in charge of any type of boiler. In a case like this it is not only the owners of the boilers who suffer from an incompetent engineer, but the boiler gets discredit in a way that is very likely to work injury to its manufacturers. Every one, including the public, is interested in having boilers in charge of competent men.

LETTERS FROM PRACTICAL MEN.

A Hack-saw Lubricant.

Editor American Machinist:

I was sawing off some Norway iron and cast steel one day not long ago, and as the saw went hard and cut slow my elbows got tired. That set me to thinking, and the outcome was I learned something new to me, although it may be old to others. Common oil will make it go easy, but slow in cutting; this we all know; but my eye fell on some chain grease that I made last summer of two parts tallow, one part graphite. I rubbed some of this on the sides of the hack saw, and wasn't I surprised to see the chips roll out? Try it, fellow workmen, and you will be good for many more years, and the saw for many more jobs.

Worcester, Mass. F. F. D.

About Milling—A Rotary Planer.

Editor American Machinist:

There is a great difference between the cutting action of axial and face cutters, and the difference I think would be still greater if the face cutter principle was used to its greatest advantage.

Axial cutters are on the principle of forming tools, as used on lathe or planers, with the exception that, in the milling machine, each tooth strikes something of a blow on the work, which, on a springy piece, causes it to take hold, where, with a forming tool and a continuous chip, the work would be pushed away.

I believe in milling the grooves in long springy taps, a heavy weight could be attached to the work, and a cutter used with few teeth, running at a fair rate of speed, so as to do good work without using a support underneath, as would be necessary without the weight. Just make the time between teeth long enough to allow the machine and work a chance to recover former position before being hit again by another tooth.

Perhaps this is a new idea in milling, but I believe a little of this idea worked into milling machines, that is, by putting in weight for the purpose of resisting this knocking tendency by its inertia, would give good results.

There must be something of this action in axial milling, otherwise we could not use cutters of near the cutting surface on this kind of work. I have seen a gang of mills cutting in cast iron about 18 inches in width; just imagine a forming tool of that width in the heaviest lathe.

I have heard of milling flat surfaces more accurately than by planing until I am tired of it. I have never seen it done, although I have watched milling operations in shops where they at least pretended to be at the top of the ladder in milling.

I don't believe it possible, or that it at all *looks* reasonable. I saw some apprentices at noontime play a joke on an old machinist. They removed the side tool from his lathe, and substituted an old plow cutter. Perhaps some do not know what a plow cutter is. It is made something like a side tool, except that the cutting edge is about 9 inches in length. The machinist thought it was no improvement, but I see people trying to play a similar joke on themselves in trying to do accurate work with a cutter of this width.

In all shops that I know anything of, when an accurate flat surface is required, the work is planed after milling.

The milling is of great advantage, as it produces about the right shape at once, without measuring, and without much attention.

Many will speed their milling cutters as they would a shaft in the lathe of the same diameter This is far from right. What damages the lathe tool chiefly is the heat generated at the point of tool, for it is a continuous cut and no chance to cool off, but with the mill there is a great chance for the teeth to cool during the remainder of the revolution, and then again, the thickness of chip has a great deal to do with the matter

Mr. Arnold, in one of your late issues, seems to think that the thickness of chip does not matter much in lathe work as affecting the speed, but it certainly does. I was once considerably surprised to see in a machine tool shop men turning machine spindles at a speed that I thought too fast for work one third the diameter.

In turning these spindles at this high rate of speed, of course, there was very little stock removed, perhaps a depth of cut of .003″ at a feed of about four or five thousandths, the object being to produce a true surface, and as smooth as possible, with little filing.

The tool used was carefully stoned, and would do what appeared to me to be a remarkable lot of work without dulling, as the stock was very hard, in fact, so hard that in roughing out it was all that the tools could do with a very slow speed. In milling the thickness of chip taken per tooth is very little, so high speed is allowable.

In Figs. 1 and 2 is shown a part of a machine that I call a rotary planer. I suppose some would call it a milling machine, but I fail to see in what way its action would resemble axial milling.

The machine altogether would resemble a planer. It would, of course, only be useful on plain surfacing, but on this class of work it should be much more rapid, and do fully as good work as ordinary planers. With a cutter head mounted upon the cross-rail of a diameter greater than the width of work platen, the tools would cut clear across the platen and should act very much the same as lathe or planer tools.

In the illustration *H* represents the cutter-head, *F* the work platen, and *K* the cross-rail of machine. The cutter-head *H* to be driven by a pinion *E* in mesh with an internal gear.

Since drawing this it looks differently to me. I should, I think, to avoid excessive friction on the circular V ways, place the pinion on the front instead of the side, as is shown, also arrange a substantial adjustable bearing in the center. This perhaps would not be practical with the V-ways, so flat ones would be necessary. Fig. 3 is a section of tool clamp through the line *A B*, Fig. 2.

This kind of a clamp allows of stock for the tools to be planed with a good face-rake the whole length, so as to only need grinding on the end.

I have no doubt there would be economy in grinding the cutters in place by the use of a special grinder bolted to the work platen so as to grind every tooth or tool exactly true.

Some might think, as there are so many more tools cutting than on a planer, that the grinding would be an objection. I believe a special grinder could be made so as to leave the margin in tool grinding far in favor of the rotary planer, for in this, when tools are ground, the man can make a specialty of it, and so do it more cheaply than one at a time. Besides, grinding in place would allow of coarse feeds without cutting roads through the work. Usually the feed marks of work finished with a face-mill represent the feed per revolution instead of the feed per tooth, as would be the case if the cutter was true.

Fig. 4 shows a very good plan for face-mill for use in ordinary machines. The cutter at *A* is as is usually made with the cut

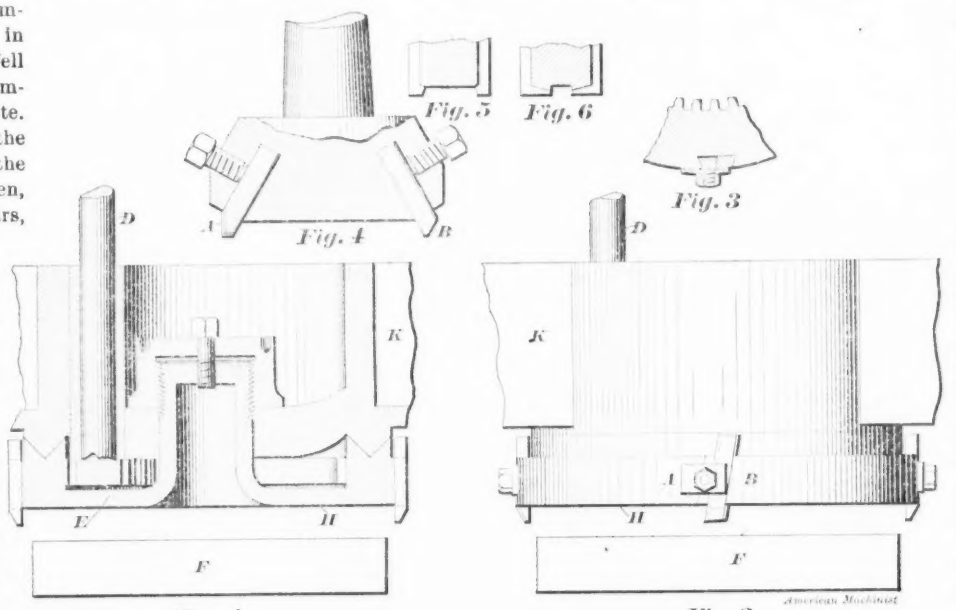


Fig. 1 *Fig. 2*

ting edge at right angles to the work, but a friend of mine says he makes them as at *B*, and finds they work much better. We find that lathe and planer tools work best when set at an angle with the work. I suppose in the case of this face-mill with the cutting face at an angle, the tendency is to force the spindle back and take care of its "backlash" better than where the cutter is like *A*. It is not necessary to have the part of tool that faces the work much wider than the feed per tooth to do smooth work.

I wish to call attention to the way solid end mills are commonly made with long face teeth as in Fig. 6. Fig. 5 works much better and is much more easily sharpened.

Where the face teeth are made so long their inner ends are very shoal and fine, so they get easily clogged with chips and are difficult to grind, besides are of no earthly use, except, perhaps, in going into the work like a drill, which, I believe, is not often necessary.

If in Fig. 5 the inner ends of teeth are cleared a little there is no trouble in starting cuts I believe. A MECHANIC.

Utilize the Waste Heat of Gas Engines.

Editor American Machinist:

The well-known Otto gas engine has been adapted to the use of gasoline which is introduced into the cylinder together with a quantity of air. The mixture is exploded or ignited by suitable means. The use of gasoline in this way reduces the cost of running per horse power hour to a very low figure comparatively. By the makers this is placed one cent per horse-power hour for fuel, which is 74° gasoline valued at eight cents per gallon.

But the relative waste is not reduced. Why cannot the water jacket of a gas engine be made a part of a hot-water heating system to warm the engine and other rooms? Of course the utility of this plan would depend on the size of engine, of engine room, and the duration of the heating season. Such a heating system is suggested in the water coolers which are erected sometimes to prevent undue waste of water by gas engines.

Where the size of the plant would warrant the expense, the heat in the waste products of combustion might be utilized to increase the circulation and consequently the capacity of the heating system. G. W. BISSELL.

Ames, Iowa.

Computing Change Gears.

Editor American Machinist:

Allow me to give you an addition relative to W. H. Croker's article in AMERICAN MACHINIST of November 9, 1893, on screw cutting. Mr. Croker is mistaken that the example he sets on a Barnes' lathe No. 5 is not in the set of gearing. He states that the set contains 16, 20, 24, 28, 30, 32, 36, 40, 44, 48 and 52. Now he wants to cut 14 to the inch. What is simpler than to find the necessary gearing in such a case? There are two figures at hand, one representing the lead screw (8), the other the desired work (14). My way, and a simpler one I have never seen, is: I take any figure as a multiplier, commencing with the smallest one to run up high enough to reach the number of teeth in the smallest gear, as in this case,

8	14
2	2
16	28

which are the proper gears without any luck whatever. I think an illustration as given by Mr. Croker is more confusing than instructive for young beginners, and not reliable for accurate work. There are a good many cases where the simple gearing will not reach the demand, but if we apply the compound gearing, then we have a great variety of changes at our disposition. I venture to say, if lathe builders would adopt the rule to furnish with screw cutting lathes a set of gearing which would advance with one tooth only, instead of 4 or 6 as the advancing order may be, it would be impossible to meet with any screw for which the gearing could not be found. The compound application offers an endless variety of cases, and is in itself almost as simple as the single gearing. It strikes me with surprise that there are so few machinists who can master this art easy. I had a case where I had to cut a nut for an old tobacco screw of which the thread was $1\frac{31}{64}$ to the inch. Had only a half a set of gearing, but found the proper ones without any error whatever. CHAS. MILLER.

Washington, Mo.

[The fact that gears are in Mr. Croker's set for cutting his examples of threads, tells nothing against his plan, which, we think, is original, very simple, and a very valuable one for those who experience difficulty with these problems, and it is especially valuable for finding quickly the closest possible approximation.

Mr. Miller's plan of multiplying both threads by the same number is correct in principle, but is also exactly the same in principle as to select the gear for the lead screw, divide its number of teeth by the number of threads to be cut, and multiply this quotient by the number of threads of the lead screw for the gear on the stud; and the latter plan has the advantage that we start out with one gear at least that is known to be on hand, and, therefore, are more likely to find two that are available. The first operation of dividing simply gives us a multiplier that we know to be right for one gear, and which may be right for the other one, whereas, by simply guessing at a multiplier, we are very liable to get two numbers, neither of which is repre-

sented by gears on hand. Besides, those who use the random multipliers usually make no use of fractional multipliers, though these may be just as useful as integral ones. Taking Mr. Miller's example, for instance, suppose the gears 16 and 28 were not in the set, then it might easily happen that the proper multiplier would be $2\frac{1}{2}$, and we would then have,

$$\begin{array}{cc} 8 & 14 \\ 2\frac{1}{2} & 2\frac{1}{2} \\ \hline 20 & 35 \end{array}$$

showing that 20 and 35 are the gears wanted. These might be in the list, in which case the man who pursued the plan we recommend would be most apt to find them. He, in choosing, would, after a few trials, select 35 for the lead screw, and, dividing this by the number of threads to be cut (14) get $2\frac{1}{2}$ for a quotient, which, multiplied by 8 (the number of threads on the lead screw), gives 20, the other gear. It is, we think, surprising to most of those who have familiarized themselves with the matter that men should find difficulty with these problems, but they do, and probably always will.—ED]

Milling Machines and Feeds.

Editor American Machinist:

I have too much respect for the milling machine to let go unnoticed Horace L. Arnold's statement (in an article in your paper December 28th) that "these aprons are thin and do not all come off flat from the milling machine. If not warped more than $\frac{1}{32}''$ they are finished at one single cut on the grinding machine which takes 40 minutes for each apron."

We also understand him to say that this apron was milled in from 7 to 8 minutes while the grinding machine required five or six times as long to finish them. My experience has led me to believe that $\frac{1}{32}''$ is far too much to allow on such work; such work as an apron for a 13″ lathe should be milled to within a limit of .005″.

I have managed a department where we milled aprons for 16″ lathes, these aprons were 22″ long and there was no trouble in working to the limit of .005″.

The aprons can be milled as cheaply in one case as in the other, and when the latter limit is worked to the time required to finish these aprons on the surface grinding machine would be greatly reduced.

I worked on the first surface grinding machine that the Brown & Sharpe Mfg. Co. made for the market, and also on about the last, but I have never yet been able to reduce the thickness of such a piece as an apron $\frac{1}{32}''$ at "one single cut" on this machine, as the emery wheels would not stand such a cut, and I am very much in doubt whether the machine had wheel spindle power enough to drive such a cut.

I have no doubt that "Englishman" that Mr. Arnold tells us about rather liked the American grinding machine as compared with the "Birmingham," but my advice to the English and American men is, don't finish your lathe aprons. It is a wrong thing to do. I once had charge of a room where we had several 16″ lathes which had these aprons finished, and after we commenced to work these tools I noticed one day that they were very dirty and corroded. I asked the foreman of the department to more carefully look after this part of his duty, but it was not long before I discovered it was almost impossible to keep them polished, as the studs, nuts, handles, etc., would not allow of polishing properly. An apron that is properly designed and cast, leaving the scale on it, except at such parts as the end of bosses, and where it is tongued to carriage, is in my opinion what is wanted for 1894.

When apprentice boy I used to surface-grind, oil-stone and polish with the finest cloth parts of machinery, the same pieces being to-day painted, and the machine is worth more to the user than the ones that were so highly finished.

"Greaser," issue January 4th, has jumped at a very funny "conclusion" regarding milling machine feeds; the facts are that milling cutters will stay sharp much longer running the "new way" than the old, and if the machine is properly arranged "Greaser's" friend need not go home nights with his "back" feeling any different than when he ran it the old way, unless his backache comes from lifting a great many more pieces to be milled in a day.

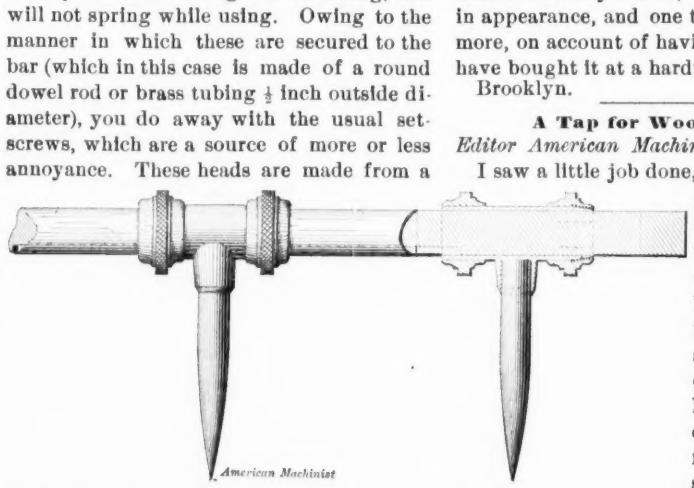
We will all learn more about milling machines and how to do good work on them, at least 50 per cent. cheaper than on the planer, when we make them much stronger and with twice the power we now have. It was only yesterday I was starting a milling machine on a job of 100 pieces, and I found the cutter (which was of quite a length) would get dull much faster on the end that was furthest from the spindle. After a careful investigation I found the support for outer end of cutter arbor allowed the cutter to spring, and am now making a new outer support, and before this machine is run again I will have the new support on it and thus do my work much faster and keep my cutter sharp longer.

JOHN A. MCGREGOR.

Trammel Heads.

Editor American Machinist:

I herewith present a sketch in part longitudinal section of a pair of trammel heads, suitable to strike a circle from three inches in diameter to one of four feet radius, and if they are neatly made they will present an attractive appearance when finished. They will be found very convenient to handle, as they will be both light and strong, and will not spring while using. Owing to the manner in which these are secured to the bar (which in this case is made of a round dowel rod or brass tubing $\frac{1}{2}$ inch outside diameter), you do away with the usual set-screws, which are a source of more or less annoyance. These heads are made from a



short piece of brass tubing $\frac{1}{2}$ inch diameter on the inside and about $\frac{1}{32}$ inch thick.

Place the tubing in the lathe, and chase a fine thread on one end, after having beveled or pointed the end of the tubing about $\frac{5}{8}$ of an inch down to a thin edge on the end.

Then make a tapered nut which will fit this end. Split the end of the tube in four pieces with a hack saw, up as far as the thread extends, or to the thickness of the nut. Do not split it so far but what the nut will cover the saw cuts, or it will look badly. After you have got the end with the screw on it adjusted so it will clasp the rod firmly and cover the saw cuts, and it is flush with the end of the tubing after being screwed up tight, cut the tubing off to $1\frac{5}{8}$ inches in length. Then make a blank nut, the outside shape being the same as the tapered one, and large enough to slip on over the outside of the tubing.

Tin the tubing on the end, using a little muriate of tin and solder. Also put some of the acid on the inside of the blank nut, slip it on to the tubing and heat it in a gas jet till the solder is melted, and also rub a little solder on the end, so as to completely hide the joint. When all the soldering is done you can clean off all the superfluous solder.

The piece of tubing, at right angles with the body of the heads, which holds the steel joints can be made from a piece of brass pipe $\frac{1}{4}$ inch diameter inside and about $\frac{1}{32}$ inch thick. Fit one end to the body of the head, and taper it as shown in cut. Tin the end next to the body of the head.

Then make your steel point from a piece of Stubbs steel $\frac{1}{4}$ inch in diameter, $2\frac{1}{4}$ inches long. Slip it into the small piece of tubing, and solder it firmly into it. Or tap and screw it in if you prefer, as by the latter means the points can be renewed. But it will not look so neat, as it will necessitate making the short tube larger. Tin the body of the head where this piece is to go and solder it to the head.

The heads are held from turning on the rod by means of a small square block of brass soldered inside of the head on the bottom side, about $\frac{1}{8}$ inch square, and it fits into the groove in the bar. By placing it in the bottom side of the hole in the head it brings the slot in the bar on the under side and out of sight. Be careful and get the small blocks in the same relative position, one to the other, or your points will stand "winding." A good way to get them out of wind is to first solder and then slip them both into the rod and mark where the other one should be. If you place the heads on your bar when using with the check blocks both opposite the ends of the bar you can always readily tell which is the "nut end" of the head.

These trammels do not have any screw attachment for delicate adjustments, but you will find that they can be moved a very small fraction of an inch, by slightly slacking the nut and moving the head along the rod with a slight pressure of the hand.

If these are made with a thick brass tubing for the bar, with a groove in it about $\frac{1}{32}$ of an inch square, with the heads nicely fitted to it, they will do very accurate work.

And if the ends of the rod are finished with an ornamented cap or plug, and both heads and rod nickeled, you will have a tool that is not only useful, but very attractive in appearance, and one that you will prize more, on account of having made it, than to have bought it at a hardware store.

Brooklyn. H. L. KENT.

A Tap for Wood Screws.

Editor American Machinist:

I saw a little job done, a few days ago, in a way that may interest your wood-working readers. A workman had some hard dry oak to fasten together with screws about $\frac{5}{8}''$ in diameter and $3\frac{1}{2}''$ long. He took one of the screws and filed the head square so it would fit a "Barber" brace and run true, then filed away one side of the thread, taking off a little more than half the diameter at the point and a little less than half next the body; with this half round tap the previously bored holes were threaded so effectually that the screws went in in that happy way sometimes called "tight and easy," leaving nearly all the power of the screw driver available for setting up the head. After the job was done I did some experimenting with that tap. Following a $\frac{1}{8}''$ hole it would run through $1\frac{3}{4}''$ dry oak very easily, making a clean full thread, without turning back to get rid of chips. In the solid wood it would make just as good a thread but required withdrawal several times in $1\frac{3}{4}''$ to clear the chips. In the end grain it would follow a hole and make a good thread, but in the solid wood the thread would be less good. The tap was very roughly made.

SUPERANNUATED.

Pressure in Suction Pipes of Pump.

Editor American Machinist:

The paper in a recent number of the AMERICAN MACHINIST upon the economy attendant upon the direct connection of a pump to a main under pressure has an interest rather of a negative quality. Under similar circumstances the habit of allowing water to flow under pressure into a well from whence it is afterwards drawn by a pump, is so common that it has come to be looked upon as correct practice, and yet there is no rational justification for so wasteful a practice. In such instances the proper place for the pumps is undoubtedly at a level so much higher than where they are actually fixed as would utilize the pressure in the suction pipe, *i. e.*, the suction well should be as high as the water can attain, and the pumps should be a little higher.

But conditions, such as the ordinary level of the ground on which the pumping-house is built, make it undesirable to go to the expense of perching the pumps in a lofty building and so they are placed low to escape the difficulty. Though perfectly sound practice there appears no good reason for throwing away to waste the energy in the supply pipe, and yet this has been done. There may be cases where this energy of approach would cause more or less of a water hammer in the pumps, but even if this did occur the addition of an air vessel or of a stand pipe would effectually cure this and frequently the energy of the flowing water would expand itself without hammer effect in forcing a little more water through the pump than that proper to its capacity.

What, after all, does this direct connection to a suction pipe under pressure really amount to? Suppose such a pump be stopped and the suction pipe and delivery main left to find their levels, then we should simply find the water would rise through the lower valve and through the pump bucket and up the rising main until it reached the level of the water in the supply reservoir. The pump would simply be in exactly the position of an ordinary pump placed below the water level, and its duty would be only that arising from the difference of the level of the water in the rising main and that of the discharge end of the same. The only fault would be that the pump rods had an unnecessary weight and this we have seen is a necessity of the position and simply a concession to circumstances.

Closely connected with this direct connection of suction pipes I might instance a convenient way I have sometimes adopted of balancing pumps, when for various reasons it has been desired to use a double barrel—one of which raises water from a well to a given height and the other raises to a tank at a further height. The lower barrel has necessarily the greater length of rods and these require balancing and to render the work even on the up and down-strokes it is necessary, with cranks opposite, to suitably divide the height of lift of the two pumps.

Where the total work of the upper pump is too great in spite of the heavier rods of the lower pump, the difference may be made up by causing the latter to discharge to a tank placed higher than otherwise necessary and allowing the water to fall from this tank down to the inlet of the upper pump thereby helping this and adding to the work of the lower pump. In this way the work may be nicely equalized on the revolution.

Theoretically such an arrangement of pump is far from perfect. Exactly the same work can be effected by a single pump with a plunger as by a pair of bucket pumps placed as above in series, the plunger being, if necessary, as large as the bucket. But the plunger pump is one which cannot be placed in any man's hands to attend. There is a large perimeter for leakage about the plunger, and to stop this there is danger of the packing being too tightly set up and an excessive stress brought on the machinery, but apart from this the use of a plunger will divide the load and distribute the work all round the revolution. Indeed if the plunger be made larger than the bucket, or if the lift above the plunger be greater than that below, the rods may be counterpoised without further balance weights, but in pump balancing one is always encountering men who have fads and will argue absolutely contrary to recognized natural laws. You may point out that the whole question resolves itself into one of foot-pounds of work done, but they will look at you over the rims of their spectacles and tell you pumps don't act according to such rules. It is hopeless to argue with them. I know one who seems to think the placing of a valve will change the laws of gravity.

A very common method of balancing a well pump is to hang a weight at the other end of the crank shaft. Now this seems a very poor way of balancing. It leaves the whole of the load of the rods and of the lift of water upon the crank-pin, and, like steam

engine crank-pins, those of pumps are never conveniently made too large for their load. A far better system of balancing is that where a rocking lever is connected by a pair of links to the crosshead of the pump, the other end of the lever carrying a balance weight, the lever ends on either side of the fulcrum having the proportion 1 to 2 or 1 to 3, or even more, the arc of the weight movement being fairly considerable. This gear is practically identical with the air pump gear of the ordinary marine engine. Its advantages are that first, all the weight of the rods is removed from the crank-pin and transferred to the fulcrum of the rocking lever; secondly, that the work remaining to be done, after making allowance for the plunger, if one is used, can be exactly halved on the up and down-stroke, and, thirdly, should any change in water level disturb the equilibrium the balance bob can be slidden to and fro on the lever to its proper position to suit altered conditions. In such a pump the balance weight is raised on the down-stroke of the pump and it helps the up-stroke. The levers and links cost something but enable a reduction to be made in the size of the bent steel crank-shaft and of the upper girders and bearings, and if the rotation be in the right direction the stress on the crosshead guide is minimized to the difference between the angular pull or push of the connecting rod and the lever links. In balancing a pump it is not that it is always necessary to its good working that its work should be distributed on the whole revolution in place of being all done on the up-stroke. There are frequently other important reasons outside the pump itself. Perhaps the motive power is a small engine which has other duties, the performance of which would be adversely affected by the irregular turning of the pump, for if a pump be entirely unbalanced the weight of the rods will retard the up-stroke and accelerate the down-stroke and seriously affect the uniformity of speed of a small engine or water wheel. My remarks apply, of course, more particularly to the care of single-barrel pumps placed deeply down artesian bore pipes, and I propose to send in the near future a calculation of the balancing in a hypothetical case which may interest some of the younger of your readers.

W. H. BOOTH.

Three Points of Support for Lathes.

Editor American Machinist:

A while ago I was facing off the side of an 8-inch gear in a 13-inch lathe, and I ran the tool just up to the work, so I could hear it strike, or make a sound familiar to all metal workers. I was then standing near the headstock of lathe, my weight being practically all concentrated near one leg, and as far as the lathe was concerned it was just like adding so much extra weight to one corner of the lathe.

I then went to the other end of the lathe on the same side, and lo, the noise of the tool scraping the side of gear ceased. I repeated the experiment several times with the same results, the floor is new and will average well for solidity. I then did some thinking thusly: It is self-evident that as lathe legs are at present made they do not occupy the same horizontal plane at bottom of feet, as they are generally left rough and just planed off on top to fit lathe bed, and for the very obvious reason that no floor is level, in the strict application of the term, nor would it stay level if it were at first made so, and to get the inequalities of the legs and any four spots on the floor to come in the proper juxtaposition, is too much for the mechanic to hope for, as my experience has taught me that chance is the last thing in the world to favor the mechanic; in fact, what is known as luck generally goes against him in doing his work and this very fact furnishes an excellent incentive to ingenious effort.

The factor of *shifting weights* is also of immense importance in a machine shop. This shifting is constantly occurring and will, to a greater or less extent, affect the alignment of all light machinery that is mounted like the average lathe, and is particularly true of the upper floors of a building. I have never found it necessary to bolt the lathe to floor, as its own weight is sufficient to keep the belt tight, if the angle from vertical position is not too great, and the only mechanical and scientific remedy for the evil, and it is a serious one, lies in making a strong hinge-joint between the legs and bed where they are at present bolted solid at foot of bed, and leave the legs at head end just as they are at present, the axis of hinge to be parallel to that of lathe spindles; this would allow the lathe to adjust itself properly under all conditions, and torsion of bed would be impossible, it would have all of the advantages of the present style in both appearance and rigidity, and support the bed on three points only, as it should be. This would involve but very little extra expense on the part of manufacturers, and the philosophy of it is, or ought to be, apparent to any mechanic.

H. H. HARDINGE.

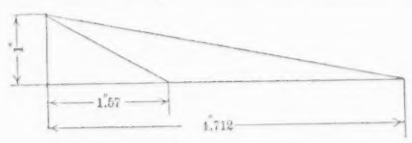
[We are not sure whether or not the above was written in the full knowledge of what has been done in this line or not, but at any rate it will not be amiss, perhaps, to state some facts regarding it.

Prof. John E Sweet, some years ago, strongly recommended that all machine tools should be supported upon three points only, he having arrived at this conclusion from some observations similar to that of Mr. Hardinge. He carried this idea out to some extent, and is to-day a believer in the principle that a machine to be placed and operated upon a floor should have a frame or bed of sufficient rigidity to resist within itself the strains imposed by its operation, and should then be so arranged as to be relieved of the additional unknown and unknowable strains, which, with the common constructions, are imposed by unequal settling of floors, or flexure of them by shifting weights. His Straight Line engine rests upon three points of support, and for some time the Pratt & Whitney Company built lathes embodying this idea in precisely the manner suggested by Mr. Hardinge, *i. e.*, they had the leg at the foot of the lathe pivoted to the bed, the axis of the pivot being lengthwise the bed. The pivot bolt was, however, inside the lathe bed, and the whole arrangement was so similar in appearance to their ordinary construction that it was easily overlooked unless one's attention were specially directed to it. We think they have not employed the device for several years past.—ED]

Angle of Screw Threads.

Editor American Machinist:

In AMERICAN MACHINIST of January 4, 1894, on page of Questions and Answers, query (14), from H. H. G., Southington, Conn., you have given an answer which appears to the writer to be misleading to the uninformed person, for it is a fact that the angle of the thread is different at every point of depth of the thread, as the following example will show: Assume a screw 1½″ outside diameter, square thread, 1″ pitch or one thread per inch, with thread and space equal in width, with depth the same; that is, ½″. Then the diameter at



bottom of thread will be ½″. The angle described by thread at outside of screw is about 11° 59′, and that at bottom of thread about 32° 30′. The following diagram will illustrate the different angles more clearly to a person not familiar with angles expressed in degrees and minutes. In this the 1″ represents the pitch of screw thread, 4.712″ the circumference of outside of the screw, and 1.57″ the circumference of bottom of thread, a wide difference in the angles, and it appears to the writer that if an angle mean of the extremes be taken, which in example would be about 22° 14′, that the shop man would get the best results therefrom, if he were seeking to get the proper angle for tool to cut such a thread.

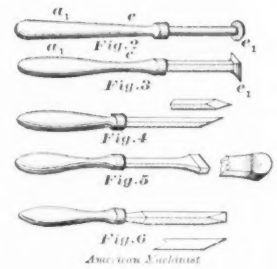
A. S. ALDEN.

Stamford, Conn.

[We thank Mr. Alden for calling attention to this matter, since, of course, as is plainly shown by him, where the thread is relatively very deep when compared with the diameter of the screw, the angles at top and bottom differ from each other very materially.

In answering the question referred to, we had in mind only V threads of such proportions as are commonly used, though in most cases the same rule will answer for square threads, and the fact that we computed the angle from the outside diameter of the screw would indicate that the angle was given for that point only, and that if the angle for a different point were desired, the corresponding diameter must be taken. However, there are many men who have a good deal to do with screws that have never investigated them sufficiently to know that the angles of the spiral at the top and at the bottom of the threads differ from each other, and it is a good thing to call attention to it.—ED.]

Fig. 1



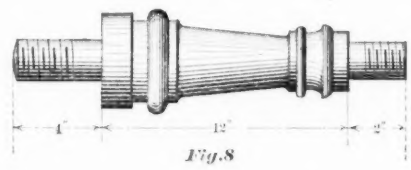


Fig. 8

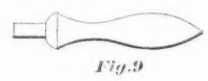


Fig. 9

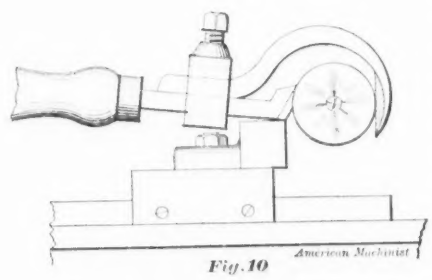


Fig. 10

Hand Tools.

Editor American Machinist:

Almost every machinist who served an apprenticeship forty years ago became familiar with hand-turning tools. Adepts in their use still find them useful at times.

There are doubtless many machinists of the new school that have not met with these primitive appliances. A description of some of them may be of interest to such. Some of those shown have long since passed out of use, and but few of the others are now found in the modern tool room.

Figs. 1, 2 and 3 are shoulder tools. They were held firmly to the right shoulder, when in use, by the left hand holding the handle at *a*, while the right hand, placed at *c*, manipulated the turning. The rest on which these were used was made rough, so that the spur at *b*, or the lower edges of the tools at *e e*, engaged and prevented slipping. To those not familiar with the use of such tools it may seem as though but little could be accomplished by their use, but in fact there are kinds of turning, such for example as that shown by Fig. 8, which, in the absence of special lathe attachments, admit of the use of hand tools, and when in experienced hands, much more and better work can be done in this way than on the ordinary engine lathe. Even in turning a handle, such as Fig. 9, the work is facilitated by the use of the smaller tools shown, especially the straight and round nosed smoothing tool, shown by Fig. 5. Figs. 4 and 6 are side tools which may be used right or left, the latter is simply a three-cornered file ground to an edge. The rest on which these tools are used should be wrought-iron, or soft steel, in order that a firm hold may be taken without dulling their edges.

As the hand suffers from bruises of the hammer, in the hands of unskilled apprentices, so the ears were made to tingle from raps inflicted by these shoulder tools, when, in an unguarded moment, the edge of the tool would become engaged with the work, be jerked violently out of the hand, and in its flight collide with the ear.

Fig. 10 represents a primitive method of screw cutting which forms a striking contrast as compared with the present development of this art. The chaser is of the ordinary kind, with an attachment for heavy work. Micrometer exactness cannot be expected of such a method, but in the absence of a screw cutting lathe, or a bolt cutter of proper dimensions, this was an excellent makeshift. Aside from the dexterous use of a pointed tool in originating a thread of the proper pitch, the handling of this chaser is quite simple. A thread, say six to an inch on 1½-inch or 2 inch iron, and 4 inches in length, may be cut inside of ten minutes. It will be seen that the operation of increasing or diminishing the cut is accomplished by simply raising or lowering the handle, and the goose-neck attachment insures uniform diameter. First-class appliances are always desirable, but when not at hand substitutes are very acceptable.

"QUIRK."

What Makes Holes in Castings?

Editor American Machinist:

Mr. W. H. Drake in your last issue wants to know what makes holes in castings; he does not give us a very good description of how his castings are made. If the boilers are cast with the open face down, unless the molder is very careful, every one will have these holes or blisters, as they are termed, as Mr. Drake has described. In ramming up the cope you should not use any facing sand, use only common heap sand on top of the pattern, nor should it be very hard on the face of the mold, and use no blacking. You will not have so pretty a casting, but you will have a good solid casting every time; also, you might have a small "riser" on top, covered in the usual way, to keep it from blowing through. It would take too much of your valuable paper to thoroughly explain the theory of these holes, but this is a positive cure. The pig-iron doesn't at any time cause this kind of hole; sulphur causes blow holes in castings, but of a different kind.

EDWARD B. GILMOUR.

The Watts-Campbell Co., Newark, N. J., have recently put in, to drive their works, a tandem compound engine of very neat design and excellent workmanship. The cylinders are 11″ and 20″x30″, and the speed is 85 revolutions. We have no doubt that a good many engineers have wondered in a general way at the superabundant weight of the wrist plate of the great majority of Corliss engines. At any rate we have never been able to assign any valid reason for the common massiveness of this piece. In this engine the wrist plates are about one quarter of the usual weight, and it is almost needless to add that the engine looks very much better for it. The steam valves of both cylinders are under control of the governor, and the engine runs very quietly. As intimated, the design is very finely worked out, with ample material, but no waste in this respect.

Paris is to build, for the purpose of handling World Fair visitors in 1900, a tubular railway eight miles long, in which trains will run on two minutes' headway. Electricity will be employed for moving the trains.

Tank steamers that will carry 5,000 tons are now in use for transporting oil.

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A Rapid Transit Proposition.

Renewed life seems to have been infused into the matter of rapid transit for New York by the proposal of a very strong banking firm to undertake the financing of the work, and invest $15,000,000 if the city will loan its credit for about $30 000,000 additional, this, as we understand, having for its object a lower rate of interest on bonds than would be possible with the bonds of any private corporation.

The presumption is that this banking firm has satisfied itself by thorough investigation that such a road as it proposes can be built within four years' time from date of contract, and at a cost not exceeding $45,000,000.

The plan is to build the road under ground, in the form of steel tunnels, driven at such a depth as will not interfere with other sub surface work; to provide two tunnels, one above the other, the upper one being for local trains, and the lower one for express trains, the latter to attain a speed of about 40 miles an hour, and both to be driven by electric motors, thus avoiding combustion within the tunnels.

It is stated that a constitutional amendment would be required to enable the city's credit to be loaned to such an enterprise, and some of the most conservative people and journals are urging that in lieu of this the city should itself build the road, or rather, have it built by a private company under an arrangement by which it would, within a specified limit of time, become the property of the city, to be leased, perhaps, to an operating company.

Though this plan is open to the objection of being "socialistic," there are at the same time the object lessons afforded by the present elevated roads' monopoly operated in a manner which is simply an aggravation to those who must travel upon them, and which yet derives a princely income from its monopoly; by the Brooklyn Bridge, which is operated much more in the interest of the people of the two cities that own it, and by the city docks, which are periodically leased to the steamship and ferry companies using them.

From an engineering standpoint, it is significant that the company, which proposes to invest in this road, and is ready to deposit with the Rapid Transit Commission $1,000,000 guarantee, does not base its proposition upon the impracticable plan proposed by the commission, but upon a double steel tunnel construction, substantially, if not identically, the same as the Greathead system, which, in our issue of January 29, 1891, we said we thought most practicable.

A Shop Belt Test.

In the two numbers immediately preceding this, we have published a very full abstract of Mr. Fred W. Taylor's recent paper on belting, read before the A. S. M. E. In this paper a subject is considered which is of very great interest to all belt users, and especially so to machinists, who not only have much to do with the use of belting, but also build machinery from which or to which power is transmitted by belting, the actual working efficiency of this machinery depending largely upon whether or not the "belts give trouble." Mr. Taylor's paper is essentially a record of a test of belting extending through a period of nine years—a test not made in a laboratory with machines and under conditions especially designed for testing, but in a machine shop, the belts being in actual use under working conditions. This fact most practical men would be apt to consider a decided addition to its value, though generally speaking it is doubtful if this is always the case, for in the laboratory test we may be better able to control conditions, and thus secure a fairer test.

The above implied limitation of many so-called practical or shop tests, as opposed to laboratory or special tests, happens to be illustrated in the case under discussion, and constitutes a point not brought out in the discussion of the paper before the society.

The conditions would not admit of any change in the cone pulleys on the countershafts and spindles of the machine tools, with the result that the comparison is mainly between vertical belts on the one hand, running on cone pulleys subjected to the greater stress per unit of area, and on the other hand, horizontal belts running on ordinary line shaft and tight and loose pulleys with shifting forks, these belts being subjected to the lesser stress per unit of area. It is assumed that the character of the service is about the same in the two cases, whereas we think the experience of most persons is to the contrary, and that vertical cone belts work under much the hardest conditions. A more instructive and conclusive test would have been made if half the horizontal belts had been proportioned according to the ordinary rules and the other half according to the rule proposed by Mr. Taylor, and if the vertical cone belts could also have been divided in the same way the value of the test would have been still further increased. Such an arrangement was not possible, however, because Mr. Taylor had first to look after shop efficiency, economy and profits, the belt test being necessarily subordinate to these.

He therefore did the best he could under the circumstances, and has given us much data that is of very great value. The results of the test make it plain, we think, that ordinary rules for belting give in many cases far too great stress per unit of area, whether economy in belt buying and maintenance, efficiency of machines, or both, be considered; also, that there has been too much avoidance of double and triple-thickness belts, especially when they are to run on pulleys of moderately small diameters.

The recent performance of the new 2,000-ton cruiser "Montgomery," by which she earned $200,000 premium for her builders, will, it is likely, revive some of the talk about collusion between naval officials and contractors, this premium being, if we mistake not, very much higher than any which has been earned before, proportionately to the total cost of the vessel. The "Montgomery" was built by the Columbian Iron Works, of Baltimore, is in the 2,000 ton class, was contracted for a speed of 17 knots, and developed on trial slightly over 19, which at $25,000 premium per quarter knot excess, gives her builders the handsome bonus named.

In answer to some criticisms that have been made, it may be well to recall the fact that in all the cases the full specifications of the vessel to be built are submitted to all those qualified to bid for their construction, and every bidder knows just what premium is offered, has just as good an opportunity as any other bidder to know what premium can probably be earned, and can, in bidding, make as much allowance for this as his confidence in his own ability to exceed the contract requirements will allow. Quarter knots of speed added to already fast boats mean vastly increased power, and cost money; it is right that they should be paid for.

President Sloan, of D., L & W. Railroad, is quoted as saying in relation to the recent fatal collision on that road, and the means available to prevent such accidents, that "we have believed that a man is superior to a machine."

In this statement taken by itself we would entirely agree with Mr. Sloan. We think that if we were compelled to choose between good men and machines (automatic block signals) to prevent accidents we would unhesitatingly choose the men. But the point is that in modern operative railroading where a road is situated as this one is no such choice should be made; both should be employed; the best automatic block signals obtainable and the best men obtainable. Only with such a combination can travelers on such crowded roads be provided with the safeguards to which they are entitled.

John H. Harris.

John H. Harris, vice-president and general manager of the Worthington Pumping Engine Company, of London, England, and chairman of the Executive Committee of the Henry R. Worthington Company, of New York, died at his home in this city on Monday, January 22d. He was born at Troy, N. Y., in 1838, and served in the navy during the war, since which he has been engaged in business in New York, for several years past, with Henry R. Worthington.

To judge from what is being said in some of the papers of England, there are those there who think that the net result of England's participation in the World's Fair will be prejudicial to that country, because "being brought into comparison with other nations, she failed to make a larger and a more effective display."

According to the annual report of the Railroad Commissioners of Connecticut, the net earnings of the railroads of that State were $559.000 greater than the year before. There was 3 per cent. increase in passenger traffic, and 2½ per cent. in freight traffic.

Literary Notes.

"THE IRON FOUNDER" SUPPLEMENT. A Complete Illustrated Exposition of the Art of Casting in Iron, comprising the Erection and Management of Cupolas, Reverberatory Furnaces, Blowers, Dams, Ladles, etc.; Mixing Cast-iron; Founding of Chilled Car Wheels; Malleable Iron Castings; Foundry Equipments and Appliances; Gear Molding Machines; Molding Machines; Burning, Chilling, Softening; Annealing; Pouring and Feeding; Foundry Materials; Advanced Molding; Measurement of Castings; Wrought iron, Steel, etc. Also the Founding of Statues; the Art of Taking Casts; Pattern Modeling; Useful Formulas and Tables. By Simpson Bolland, Practical Molder and Manager of Foundries; author of "Iron Founder," etc.

This book is intended by the author to complete the work begun in "The Iron Founder." An outline of the subjects treated in the supplement is given on the title page, quoted above, and need not be further specified by us. The author is well known to our readers through many of his articles which have appeared in our columns. He is a thorough, practical man, has had a wide range of experience, and is well fitted to write on foundry matters. With all he has the happy faculty of expressing his ideas in a clear, interesting, and comprehensive style, so that others will have no difficulty in understanding what he has to say on the different subjects on which he treats. The book gives evidence of conscientious labor and research, particularly so in the chapter on founding of statues in iron and bronze, which forms a very important and valuable feature of the book. Molders and apprentices who wish to progress in their business, and all others who wish to become familiar with the art of casting in iron and obtain reliable facts and data, cannot do better than procure a copy of this work. It is published by John Wiley & Sons, 53 East Tenth street, New York. Price, $2 50.

THE CORLISS ENGINE, by John T. Henthorn; and its Management, by Charles D. Thurber. Edited by Egbert P. Watson. Third Edition. Enlarged. With an Appendix by Emil Herter.

In this little book of 96 pages, the setting of the valve gear in the Corliss engine is explained; indicator cards criticised, the action and management of the air pump discussed. It also contains remarks relating to the management of the Corliss engine, care of main driving gears, heating of mills by exhaust steam, and engine foundations. In the appendix the approximate diameter of fly wheels, speed of rim, average piston speed, permissible pressure on main bearings, crank pins, guide blocks, and crosshead pins are given. It also contains a table of horse power, and the principal dimensions of Corliss engines. The book is practical in character and contains much useful information, but it is to be regretted that the subjects are not stated in as clear and concise a manner as one would expect in a book of this kind, and as practical men demand. It is published by Spon & Chamberlain, 12 Cortlandt street, New York. Price, $1.00.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(52) L. A. H., Boston, Mass., writes: In a recent issue of your publication you refer, in speaking of nickel steel, to a paper read before the Society of Naval Architects and Marine Engineers in New York, by R. W. Davenport, on the production of heavy steel forgings in the United States. Can you furnish me with a copy of this paper, or advise me where I can obtain the same? *A.*—The only way to obtain it, if it can be obtained, is to write to W. L. Capps, Esq., Secretary Society Naval Architects and Marine Engineers, 1710 F street, N. W., Washington, D. C.

(53) C. Reader, ———, writes: We have dies making tin shingles out of I. C. tin 10x14. We wish to make them of black iron 28 gauge. The iron will not stand the impression of the dies, being very hard. Kindly inform me of a good and fast process of softening it? *A.*—So much depends upon conditions unknown to us that we cannot advise as to details, but there is only one general method known to us for doing such work, and that is to heat and allow to cool slowly. If the pieces are blanked out before being stamped, they may be laid in piles of convenient weight, wired together, and heated in a furnace, and this is probably the only practical method for you to pursue. It is better, however, if not too late, to get iron suitable for the work as it comes from the mill.

(54) F. E. M., Dayton, O., writes: Please give me a receipt for a liquid solution for case-hardening machine steel and wrought-iron? *A.*—Melt cyanide of potassium in a crucible thereby obtaining a bath, in which heat the articles until they are red hot; then take them out and cool in water or oil. Some recommend equal parts of cyanide of potassium and common salt fused together. By way of caution it may be said that this process of hardening will pit some kinds of steel, but this does not occur in iron. 2. How does Jessop's steel compare with other English and American makes for tool purposes, especially milling tools? *A.*—The selection of steel is to a great extent a matter of personal preference. Nothing but your own experience will enable you to select the kind of steel which is best adapted to the work you have to do.

(55) G. H. M., Boston, Mass., writes: Please give formula for making a soldering fluid which will not rust iron or steel when applied to the same. I have used such a fluid, but I do not know how it is prepared. *A.*—It is said that a teaspoonful of chloride of zinc in two ounces of alcohol will make a soldering fluid that will not tarnish or rust the work. 2. Can aluminum be soldered? *A.*—There are several patents on soldering aluminum, but, so far, it seems the results are not always satisfactory; in some cases the fluid eats the metal, and the seam does not hold. Inventors are still experimenting to overcome the difficulties. A soldering metal for aluminum has been prepared by Mr. Alexius Rader, of Christiania, Norway, which is said to give good results for a variety of different metals, but is specially adapted to aluminum. It consists in combining cadmium, zinc and tin mixed in the following proportion: Cadmium, 50 per cent.; zinc, 20 per cent.; tin, the remainder. The zinc is first melted in any suitable vessel, when the cadmium is added, and then the tin in pieces. The mass must be well heated, stirred, and then poured.

(56) S. M. A., Sanford, Fla., writes: Please tell me how I can weld Kalamein tubes, or if they cannot be welded in what way can they be put together? I know I can braze them, but I am told that they have been successfully welded, and I would like to know the process. *A.*—We referred this question to the National Tube Works Company, manufacturers of these tubes, who reply as follows: "Kalamein tubes cannot be welded without injury to the protective joint. It was some time before a means could be devised to safe-end this class of tubes, irrespective of injury to the protective joint on account of a certain amount of lead being in the alloy. A way was devised, however, by which these tubes can be safe-ended in a thorough manner. The alloy is supplementarily incorporated into the body of the tube at a very high heat, and irrespective of the necessity of removing the materials of the alloy in order to get a perfect weld, the ingredients or composition naturally volatilize under the more intense heat necessary to the welding operation." We do not know of a way for making a joint in boiler tubes, except it is by brazing as you state.

(57) H. H., Guttenberg, N. J., writes: I have a brass roll 16 inches long, 5¾ inches diameter, which I wish to groove lengthwise, 44 grooves to the inch. Can you tell me of a way to do it? *A.*—A roll 5¾ inches diameter is 18.0642 inches in circumference, and this multiplied by 44 gives 794.8248 grooves as the number required to be cut. It is impracticable to cut a fractional number of grooves of uniform pitch, and therefore the nearest integral number must be taken, which is 795. There are various ways of indexing this number, and we select that which is likely to be most practicable, which is as follows, according to the computations of Mr. Walter Gribben: Put the job in a B. & S. No. 1 universal milling machine, or a machine having a similar plate and worm-wheel, and make an index move of $\frac{2}{47} + \frac{17}{47}$. That is to say, first make a cut, then release the back pin and move the plate in either direction two holes. Have the regular index pin in the 47 circle, and then move this pin in the same direction 17 holes, and repeat these operations until all the grooves are cut. There will be, the first time around, wide gaps left between the grooves, but that will make no difference; just keep on going around until all the grooves are cut. Mathematically this will not be exact, but as the total error would be only .0054 inch if the teeth were 1 inch circular pitch or actually in this case .00012 inch, it may be neglected.

(58) C. H. H., Bridgeport, Conn., writes: Please inform me how to determine the amount of cooling surface required for a keel condenser connected to a compound engine with cylinders 6 and 12 inches diameter and 9 inches stroke, cutting off at ⅔ stroke in the high pressure cylinder. The engine is to be run at a rate of 300 revolutions per minute, with an initial steam pressure of 150 pounds. Please state how this cooling surface is computed? *A.*—An approximate rule which generally gives good results is to allow 10 square feet of cooling surface per indicated horse power. Your engine will develop, if the steam ports are large enough to keep the initial pressure up to the point of cut off, and otherwise correctly constructed, about 120 horse power, and will require $120 \times 10 = 1{,}200$ square feet of cooling surface in the keel condenser. 2. How do you compute the horse-power of a compound engine? *A.*—Find the mean effective pressure under the assumption that the total number of expansions occur in the low-pressure cylinder, as explained in our issue of November 16, 1893. Then find the indicated horse-power by the ordinary rule for simple engines on the assumption that the whole work is done in the low pressure cylinder, with a mean effective pressure found as stated above. For instance, if the total number of expansions occur in the low pressure cylinder, the mean effective pressure will be 78 pounds. The ordinary rule for finding the horse-power of simple engines is:

$$\frac{P \times L \times A \times N}{33{,}000},$$

in which P = the mean effective pressure = 78 pounds in this case, L = length of stroke in feet, A = area in square inches of the low-pressure cylinder in this case, and N = number of strokes per minute = twice the number of revolutions per minute. Substituting for the symbols their values, we have:

$$\frac{78 \times .75 \times 113.1 \times 600}{33{,}000} = 120$$

indicated horse power. This, of course, should be taken as an approximation, as in practice the initial steam pressure will not be kept up quite to the point of cut off; this and other losses of steam pressure inherent in compound engines will somewhat reduce the power as found above.

(59) F. A. S., New York, writes: The accompanying sketch shows a steam drum 42 inches diameter made of plates ⅜ and ½ inch thick. The thicker sheet is drilled full of tube holes 3¼ inches diameter, 6 inches from center to center longitudinally, and 4¼ inches from center to center circumferentially. The safe tensile stress of the metal is 11,000 pounds. What will be the safe steam pressure in this drum? And how is it computed? *A.*—Let us first consider the strength in the circumferential direction. For this purpose we may assume the drum to be divided into strips a a, 6 inches wide, which is the distance between the centers of the holes. In each strip we then have solid metal 2¾ inches wide and ⅜ inch thick, the area of this is $2.75 \times .625 = 1.71875$ square inches. Since the safe working tensile stress of the metal is 11,000 pounds per square inch, the metal between the holes will offer a resistance of $1.71875 \times 11{,}000 = 18{,}906.25$ pounds. The force which this metal has to resist will be equal to the width of the 6-inch strip multiplied by the radius of the drum and by the steam pressure p per square inch; or $6 \times 21 \times p$. Consequently we have $6 \times 21 \times p = 18{,}906.25$, and

$$p = \frac{18\,906\,25}{6 \times 21} = 150 \text{ pounds per square inch.}$$

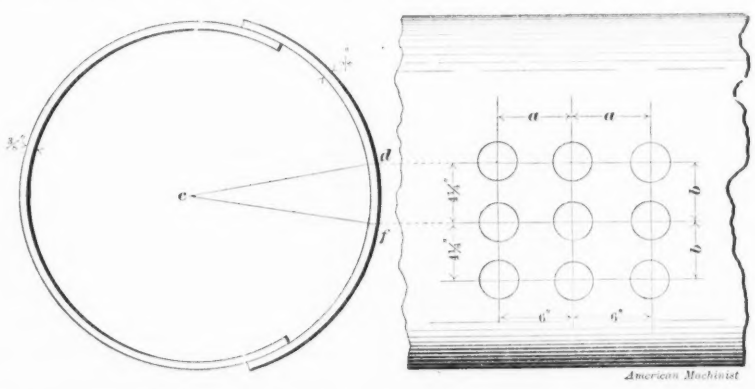
Now let us consider the strength of the drum in a longitudinal direction. For this purpose we divide the drum in longitudinal strips b b 4¼ inches wide. In each strip there is solid metal 1 inch wide and ⅜ inch thick, and this will offer a resistance of

$$1 \times .625 \times 11{,}000 = 6{,}875 \text{ pounds.}$$

The force which this metal must resist is equal to the area of the triangle c d f multiplied by the steam pressure p per square inch. The area of this triangle is found near enough for all practical purposes by multiplying the radius of the drum by the distance between the centers of the holes, 4¼ inches, and dividing the product by 2. Hence the force which the 4¼ inch strip must resist is equal to $\frac{1}{2} \times 4.25 \times 21 \times p$, equal to $44.625 \times p$. Hence we have $44.625 \times p = 6{,}875$ pounds, which gives us

$$p = \frac{6{,}875}{44.625} = 153 \text{ pounds per square inch.}$$

From the foregoing we should say that the drum can safely withstand a steam pressure of 150 pounds per square inch. The riveted joints, unless well made, may prove to be the weakest part of the drum. No data relating to these is given, and consequently we cannot compute their strength.



(60) J. B. P., Brooklyn, N. Y., writes: I am rather puzzled over a portion of Mr. Charles T. Porter's article in your issue of August 10th, treating on the "Limitation of Engine Speed." In it he gives 3,759.5 pounds as the sum of the centrifugal stresses exerted equally in all directions in the plane of revolution, and I believe I see how he gets this figure. If I understand it, this 3,759.5 pounds is the total force exerted outwardly against the rim of the fly-wheel. If this is so, then it seems to me that the calculation of the forces tending to separate the wheel on any diameter is analogous to that in boilers. The pressure per unit length of rim would be obtained by dividing 3,759 5 by $2\pi R$, in which R = radius of fly-wheel, and the tension on the two sections of the rim would be this quotient multiplied by $2R$, so that the result would be 3,759.5 divided by π, instead of 4 as Mr. Porter has it. I do not suppose that Mr. Porter has made a mistake, and, therefore, I believe I failed to follow his reasoning at some point. His geometrical reasoning is not at all clear to me, and I wish you would straighten me out. *A.*—We referred this matter to Mr. Porter, who replies that "the portion of the article to which exception has been taken contains an error which has been corrected, and in Transactions of the Society the statement is correct." We may, however, state that the action of the centrifugal force tending to burst the rim of the fly-wheel is analogous to the steam pressure in a boiler tending to burst it. A very simple and reliable rule for computing the bursting stress per square inch of section of the rim of the fly-wheel is as follows:

$$V^2 \times .1 = S,$$

in which S = stress per square inch of section of fly-wheel, and V = velocity in feet per second of a point in the center of the section of the rim. (It should be observed that it is not quite correct to take the point in the center of the section, as above stated, but it is sufficiently accurate for practical purposes). The correctness of the formula is fully demonstrated in our issue of August 20, 1891. To show the application of the formula, let us take the following example: What is the stress per square inch of cross-section of the rim of a fly-wheel whose diameter measured from center to center of rim is 5 feet, making 300 revolutions per minute? The velocity per second at the center of the rim will be:

$$\frac{300}{60} \times 5 \times 3.1416 = 78.535 \text{ feet,}$$

and the stress per square inch of cross-section of rim will be:

$$78\,535^2 \times .1 = S = 614 \text{ pounds.}$$

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila., Pa. See p. 12.

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

Chucks, the Nat'l, est'd 1882. 39 Cortlandt St., N. Y.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N. Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

"Widening Use of Compressed Air;" pamphlet free. Clayton Air Compressor Works, 45 Dey St., N. Y.

Steam Pressure Regulators, Reducing Valves, Safety Checks. Foster Engineer'g Co., Newark, N. J.

Upright Drills, stationary head, W. & L., with or without B. G. J. E. Snyder, Worcester, Mass.

M. E. Howard, Indianapolis, Ind. Specialty, 4 and 8 H. P. engines in stock, write for price.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

For best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th St., N. Y. Send for des'n.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3225 Powelton Avenue, Philadelphia, Pa.

The American Packing Ring delivers every ounce of steam that gets into the cylinder to the crank-pin. J. H. Dunbar, Youngstown, O.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Use of the Indicator for Continuous Records in Dynamometric Testing.*

BY WM. S. ALDRICH, MORGANTOWN, W. VA.

For variety of purposes the steam engine indicator is probably one of the most serviceable spring pressure recording instruments at the command of the engineer. It has reached a high degree of mechanical perfection for its particular use in steam-engine testing. Notwithstanding its well-known defects when applied to this purpose, it seems only possible to perfect further its mechanical construction, so long as its typical piston mechanism is adhered to. Still, this is not an inherent objection to the use of the indicator in some other lines of recording work, and the purpose of this paper is to show how it has been so applied in power testing with a dynamometer. It is sometimes better to make use of an instrument which has been brought to a high degree of perfection in one field of work than to undertake the development of new and untried forms of apparatus for limited and usually special tests. Taking the indicator, therefore, as we find it, and

* Paper presented at the New York Meeting (December, 1893) of the American Society of Mechanical Engineers.

not delaying work in which it may be used to advantage till it (or a similar instrument) becomes what it ought to be, the steam engine indicator will be found extremely serviceable in obtaining short continuous records in power tests.

Almost all tests of this character may be reduced to the measurement of a more or less variable pressure, depending on the amount of energy being absorbed by the dynamometer. This pressure is usually measured as a pressure on a platform scale, or by the maintenance of a weighted lever in a position of equilibrium, or by the simple pull on a spring balance. But this pressure may be transferred or transmitted to any other instrument designed for recording variable pressures, as the indicator, for instance. In some cases, simple mechanical connection may be used, while in others, hydraulic connection will be found desirable.

Mechanically transmitting the pressure from the arm of the dynamometer, by a linked connection, to the indicator piston, enables us to turn the indicator into a recording spring balance. In this method its piston mechanism is not in the least objectionable, serving merely as a guiding mechanism.

In the transfer of the pressure from the dynamometer arm to a diaphragm, which in turn presses upon water, oil, or mercury, in a closed vessel, and thence, by pipe or tubing, to the cylinder of the indicator, we make use of it as a recording pressure gauge. Small variations in pressure, slowly increasing or decreasing, yet of comparatively short duration, are not faithfully recorded on account of the retarding effect of friction of the indicator piston; but the leakage past the piston will be the least. Rapid and extreme variations in pressure, as well as extreme pressures, maintained for any length of time, are sure to result in more extended leakage, even when mercury is used under the indicator piston, as arranged for the form of the "U" manometer. When the greatest sensitiveness of the indicator is most desired (with small pressure variations) it is least obtained. It would therefore be much better to use some form of diaphragm, or closed tube pressure-recording gauge. It should be capable of enduring much more rapid and extreme fluctuations than any on the market at present.

The requirement of an absolutely closed system, under all conditions of use of the hydraulic connection, corresponds to the necessity for inextensible (or rigid) parts or members of a linked connection. In either case, there must be an invariable relation, or fixed proportionate transmission of motion, from the dynamometer lever arm to the indicator piston. The extent of movement of this piston must correspond exactly to the pressure which produced that movement, while the piston is reacted upon by the indicator spring.

The time interval must be short, during which the power absorbed by the dynamometer is to be measured and recorded by the indicator, as at present constructed. For tests of from one to two hours' duration (the usual laboratory limit) a larger drum might be substituted; that is, a drum with as large a diameter as possible, consistent with the present distance between the axis of the drum and the indicator cylinder. It is understood that the drum is only turned once during the time interval, as at present in engine testing.

Turning the drum by leading the cord (better, stranded German silver wire) to the leading screw of a shop lathe will be found quite satisfactory for almost all cases of shop and laboratory testing. It is true that the shop engine is required to do a variety of work, and whether it turns the grindstone or the drum of an indicator, its more modern type is reliable. With steady steam pressure, and shop work to perform which is only slightly variable, it will be found more readily and scarcely less satisfactorily harnessed to the indicator drum than a fine astronomical chronographic movement.

In passing, it may be well to note the necessity for a light-powered uniform mechanical movement, for general shop and laboratory testing, for other timing besides that as above noted in connection with the indicator. It appears that the change gear system of an ordinary screw cutting lathe has been so well developed and is so admirably adapted to a wide range of speed changes that all that is further required is to gear on such a system, or its like, to a small motor; and this motor should be preferably driven by a weight, and its speed controlled, as in chronographic movements, mechanically, by a delicate friction governor, or by a gravity or electric contact arm.

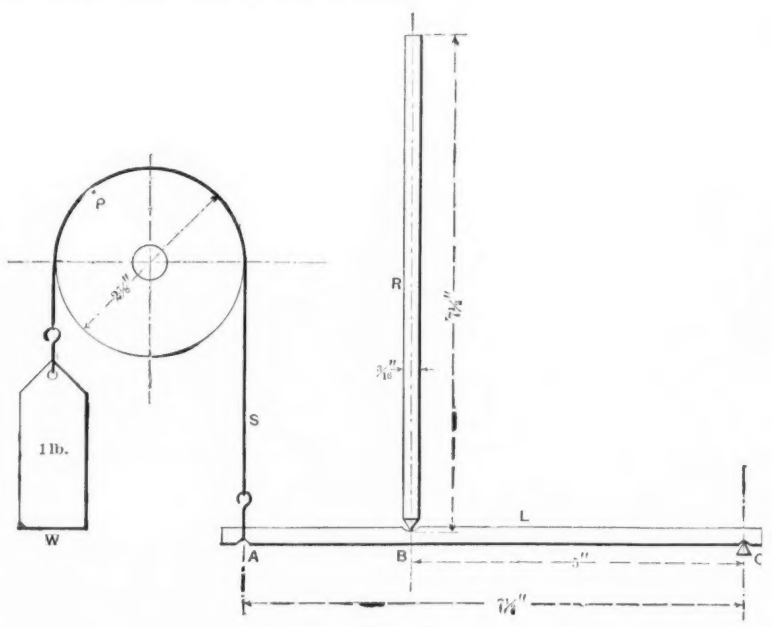


Fig. 1.

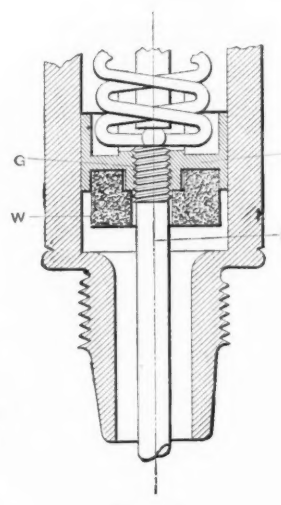
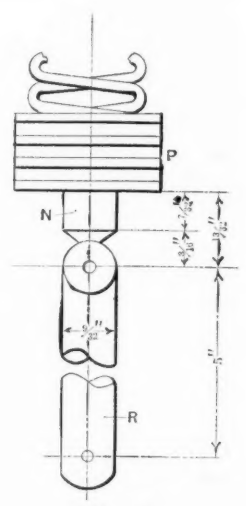


Fig. 2.



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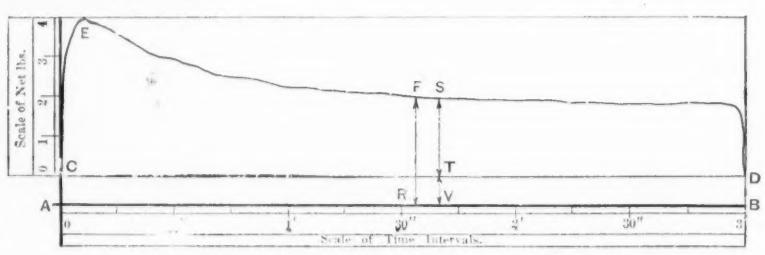


Fig. 4.

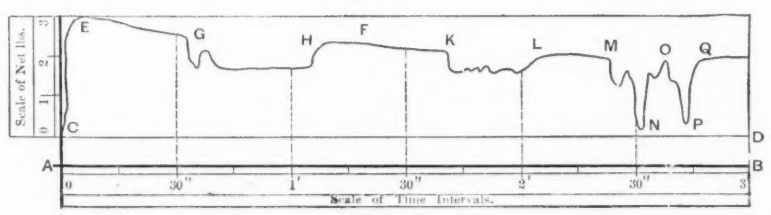


Fig. 5.

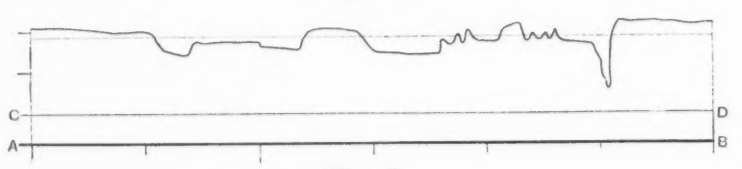


Fig. 6.

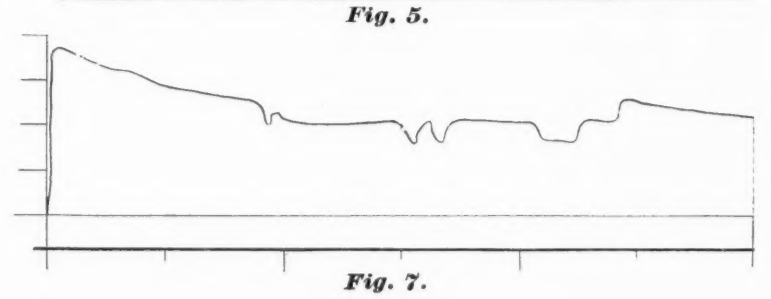


Fig. 7.

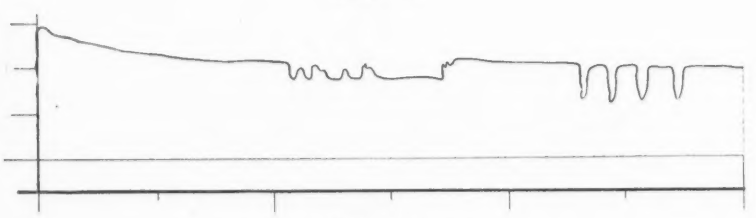


Fig. 8.

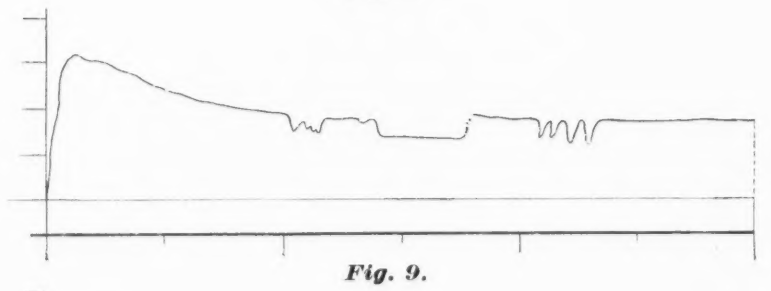


Fig. 9.

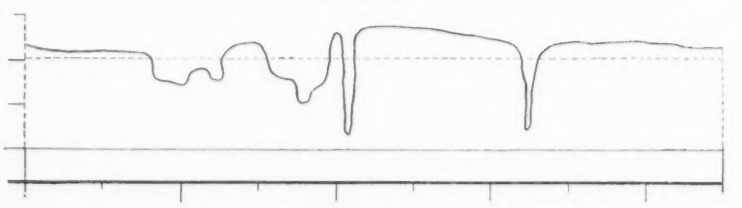


Fig. 10.

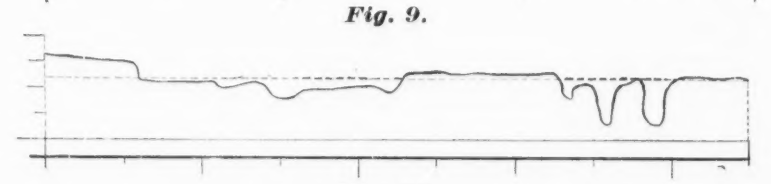


Fig. 11.

Each, of course, has its field of usefulness. Work should not be neglected because the time intervals involved cannot be measured absolutely to within the one-hundredth of a second. Moreover, it will be found that the possible changes on an ordinary screw-cutting lathe are as extensive as may be desired for almost any kind of time movement. They are so much more varied, in fact, that I have found no maker of chronographs as yet anxious to furnish an instrument with one-tenth of the possible ranges of speed of which the shop lathe is hourly capable. The cylinders of the finest chronographs are back-geared to turn once in ten seconds and one minute; or, once in thirty seconds and one minute.

It should be borne in mind that besides the above quantitative records, others, purely qualitative in character, may be desirable. For this purpose it is amply sufficient to draw the cord attached to the indicator drum along by hand. In this way most interesting, and it may be valuable, information can be recorded respecting the performance of a dynamometer; or some characteristic of its load variations examined into, without requiring to find the mean pressure exerted by the dynamometer arm, or the mean load. Such characteristic variations may be due to changed conditions of the rubbing surfaces, in friction dynamometers, or to speed changes, or both. The records from the use of hydraulic connection are more of a qualitative value, as showing the fluctuations of power absorbed, and the time of occurrence of such, owing to the errors in the recorded pressure arising from leakage past the indicator piston.

The timed records are integrated, by the planimeter, in the usual way, for the value of the mean ordinate, in this case, the mean pressure recorded. This corresponds to a certain mean pressure given off by the dynamometer arm, as found by plotting a curve of calibration of pressures, connecting those of the dynamometer arm with those of the indicator spring. In this way the mean or average pounds of effective pull on the dynamometer strap or other friction-absorbing device becomes known, from which the power absorbed is computed as usual.

I. MECHANICAL TRANSMISSION OF THE DYNAMOMETRIC PRESSURE.

In testing a No. 1, 6-inch, Pelton water-wheel, absorbing only a fraction of a horse-power, at high speed, the arrangement shown diagrammatically in Fig. 1 was adopted. The light leather strap, *S*, passed over the motor pulley, *P*, and was attached at the lower end, *A*, to the lever arm, *L*, while the other end supported a counterweight, *W*, of 1 pound. The lever moved upon a knife edge, at *C*, and pressed the rod, *R*, firmly against the piston of the indicator. Fig. 2 shows the arrangement of the upper end of this rod, *R*, pressing directly against the piston screw, *G*, and inclosed by a rubber washer, *W*. Fig. 3

shows a linked connection, designed and specially made for this purpose, by the Crosby Steam Gauge and Valve Co. The piece, *N*, is screwed into the piston, after the regular screw, *G*, is removed.

In making the tests, the indicator cord was attached to the tool post of a lathe, and driven by the leading screw, the change gears being arranged for any definite time movement, as may be desired; thus, for a three-minute interval, as shown in Figs. 4 to 9, inclusive. After pulling the cord taut, the time interval was noted, either by marking the card and noting the time, or by touching the lever (or other part of the system, as outlined in Fig. 1), and thus causing the indicator pencil to make its own time record. In this way several time cards were taken and compared. The speed of the leading screw was also noted, from which, and its known pitch, the time interval for any combination was readily obtained, and the time base of the cards drawn, as shown. The pressure scale was determined by using a standardized spring balance, reading to one-fiftieth of a pound, and plotting the pencil movement corresponding to equal increments of weight, as 1 pound, by attaching the hook of the spring balance to the hook at the end, *A*, of the lever, *L*, the weight, *W*, remaining on, as during the subsequent tests. By this means, the net or effective dynamometric pressure (a pull) was recorded at once, and the scale of pressures drawn according to this calibration. On the cards, the line *A B* is the indicator zero, found by relieving the rod, *R*, of any pressure upon it, and taken either while the motor is at rest, or running; the line *C D* is the dynamometer zero, taken while the motor is at rest, or drawn according to the previous calibration for this line, as compared with the indicator zero.

Fig. 4 was taken with oiled graphite on the strap, and shows characteristic variations, due to starting with a cold dynamometer pulley, and of stopping after it had been much heated by friction in running. The gradual fall of the line, from *E* to *F*, is caused by the decreased friction due to the heating of the pulley. The ordinate *F B* is the total pull on the strap; *T V* the pull due to the counterweight, *W*, and the other parts of system of leverage acting with it, amounting to 0.75 pound, on cards of Figs. 4 to 9, inclusive; and *S T* is the net or effective dynamometric pressure at the point considered.

Fig. 5 shows running variations, as follows: After starting, the effective pull or pressure, due to the friction of the strap on the pulley, fell from *E* to *G*, as above noted; then a hydrant in the system of piping, branching off from the main water supply pipe leading to the motor, was slowly opened and closed, then left open to *H*; after closing the hydrant, the friction pressure fell, as usual, from *H* to *K*, while the pulley became more heated; the hydrant was opened at *K*, and closed and opened in quick succession, to *L*; *L* to *M* shows the usual effect of the heating of the pulley; from *M* to *N*, the throttle valve (a hand-wheel gate valve) was closed in part, opened, closed almost entirely, at *N*, opened again at *O*, then rapidly closed to *P*, and opened to *Q*, remaining open to the end of the card.

Fig. 6 is a power card. The area, above the line *C D*, as found by a planimeter, is 3.29 square inches, its length is 5.4 inches, giving the mean ordinate of 0.609 inch; from the pressure scale, 0.325 inch corresponds to 1 pound; therefore the mean effective dynamometric pressure is 1.87 pounds. The total speed, as counted by a Tabor revolution counter, for the three minutes of the run, was 4,100 revolutions, giving 1,366 revolutions per minute. The pulley has a mean diameter of $2\frac{7}{8}$ inches, from all of which the horse power is computed, as follows:

$$\text{Dyn. H. P.} = \frac{\text{Mean effec. Dyn. Pres.} \times \text{Cir'm (ft.)} \times \text{Mean R. pm.}}{33{,}000}$$

$$= \frac{1.87 \times 0.7525 \times 1{,}366}{33{,}000} = 0.0582.$$

The mean dynamometric pressure is shown on this and subsequent power cards by a dotted line.

Figs. 7, 8 and 9 show characteristic starting and running variations, the former two cards, with dry graphite only on the strap, from cold condition of the pulley; and the last card with oiled graphite (powdered or flaked), also with cold pulley, at the start. The small variations in the curves are due to a hydrant being opened and closed, and the larger variations to the throttling of the water pressure, at the gate throttle valve.

Fig. 10, as well as all of the preceding cards, were taken with a 10 pound indicator spring, acting at the leverage, and by the arrangement, as shown in Fig. 1, of 5 to $7\frac{1}{2}$ inches. But Fig. 11 shows a card, taken with a 20-pound indicator spring, and leverage of $2\frac{1}{2}$ to 5 inches; that is, the indicator rod, *R*, was midway between the fulcrum, *C*, and the other end, *A*; and the Crosby link connection, Fig. 3, was used. The time interval of cards, Figs. 10 and 11, was four and one-half minutes, and the total speeds, respectively, 6,800 and 6,900 revolutions, from which, and the other data, obtained as previously explained, the dynamometric horse-power was computed.

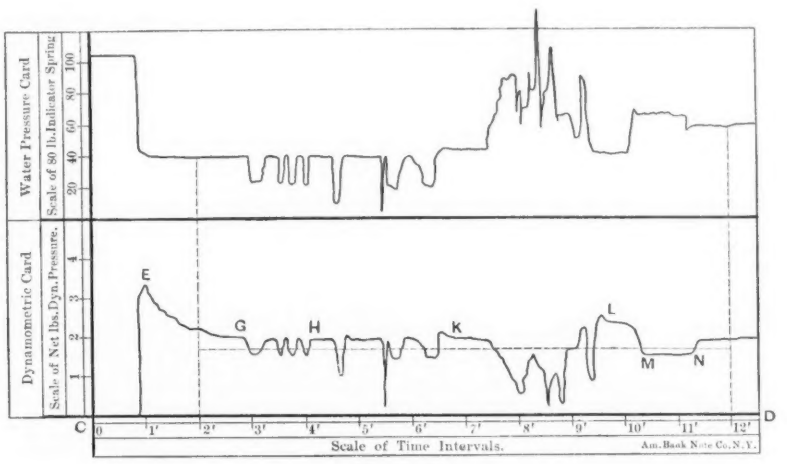


Fig. 12.

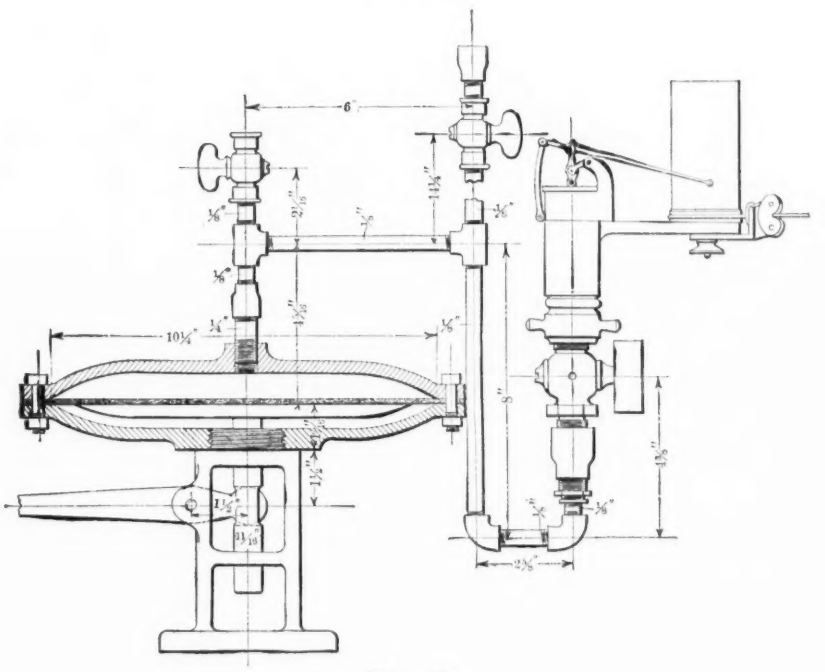


Fig. 13.

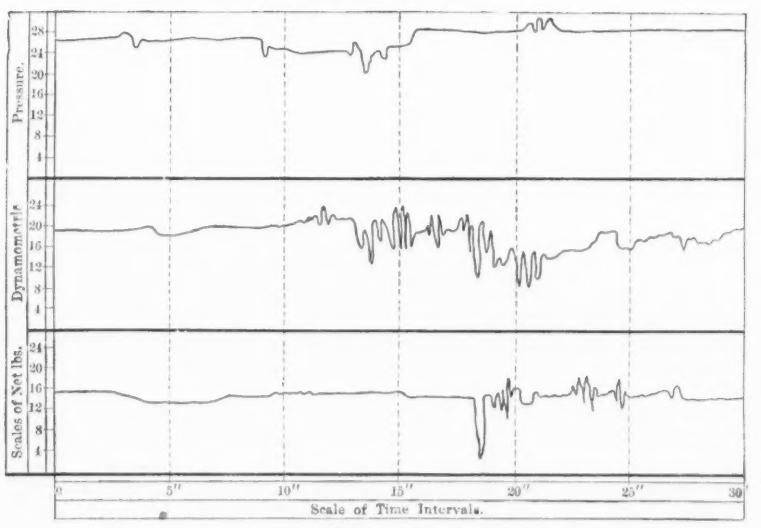


Fig. 14.

Fig. 12 shows simultaneous dynamometric and water-pressure cards, taken for about twelve and one-half minutes, but only ten minutes of this period were used to find the mean speeds, pressures, and horse-power, beginning at the 2-minute ordinate, as shown, after the motor had settled down to almost steady running. The dynamometric card was taken with a 10 pound spring in the indicator, using the Crosby link connection of Fig. 3, with the leverage of 5 inches to $7\frac{1}{2}$ inches as shown in Fig. 1. The strap was thoroughly covered with oiled powdered graphite. The water-pressure card, showing the starting and running variations in the head of water, was taken with an 80-pound indicator spring, the indicator being located between the gate throttle valve of the motor and the main stop valve of the line supplying the water, and its drum being drawn simultaneously with that of the other indicator. From *G* to *H* the variations are due to opening and closing a hydrant in the system branching off the main supply pipe; from *H* to *K* the main stop valve of the pipe line was partly closed, and wholly closed for an instant; from *K* to *L* the motor's gate throttle valve was partly closed, and wholly closed for an instant; from *M* to *N* the motor was running with its own throttle valve partly closed, being fully opened again at *N*. From the 2-minute to the 12-minute ordinate, the integrated area is 2.22 square inches, the length of this time base is 4.125 inches, giving the mean ordinate as 0.538 inch, or 1.656 pounds, on the vertical pressure scale of 0.325 inch to the pound dynamometric pressure. The total speed for the ten minutes was 12,100 revolutions, or a mean speed of 1,210 revolutions per minute, giving the dynamometric horse-power of 0.0457.

II. HYDRAULIC TRANSMISSION OF THE DYNAMOMETRIC PRESSURE.

Fig. 13 shows the arrangement adopted in this case. The variable pressure to be measured and recorded was applied at the end of the lever arm, shown below the diaphragm casing. The pressure was thus transmitted to the diaphragm, through the vertical stem pressing against the enlarged plate beneath the diaphragm—a rubber disk about $\frac{1}{16}$ inch thick. The casing and system of piping above the diaphragm was filled with water, after the "U" tube had been filled with mercury up to the indicator piston. The cock directly over the diaphragm was for the escape of air while the system was being filled through the stand of pipe to the right. Before filling the "U" tube with mercury it was first filled with a high grade of oil, then the mercury poured down the pipe to the left of the indicator till it reached almost to the level of the horizontal branch leading to the diaphragm. In this way the "U" tube system, as well as all parts of the indicator connection, became lined with the oil, which flowed out of the escape holes of the indicator as the mercury slowly rose up to the same level. To put the indicator piston in position it was pressed down upon the mercury, which was allowed to escape through the small drain hole in the indicator cock. In this manner a practically closed system was obtained, as free as possible from air.

Fig 14 shows three cards, arranged on the same time base, as taken by this method. The scale of pressures is the same in each case, and is taken from a calibration of the indicator, in this position, for four-pound increments applied at the end of the lever arm, shown below the diaphragm of Fig. 13. In running the pressure up above 28 pounds for this calibration, the mercury oozed out of the indicator escape holes as the lever arm was further pressed down to hold the pressure of calibration.

With an absolutely closed system this method adapts itself to traction dynamometric work,* the pull (or push) being entirely by and through the lever arm above referred to, and thence transmitted to the pressure recording gauge placed anywhere inside the car. Of course, the chart of this pressure-recording gauge may be moved by belting to the car axle, or otherwise timing its movement with that of the car, as with the Boyer speed recorder. But it cannot be integrated for mean values, in this instance, unless the car speed remains absolutely uniform, which is never the case. Therefore it is best to drive the recording chart by means of clock mechanism, attached to the same, and placed with it inside the car. To prevent derangements due to starting suddenly and to unforeseen extreme variations, a safety-valve air chamber may be introduced in the system of piping leading from the diaphragm to the indicator. This method of relief would become immediately operative, so soon as the pressure within the system exceeded the limit of the safety valve.

As a machine tool dynamometer, also, the method outlined above will be found useful in measuring and recording the pressure upon the work undergoing cutting operations, as in drill press work, the working pressure of which would be recorded by placing the work in direct connection with the lever arm of the dynamometer. If the pressure gauge chart be moved by connection to the automatic feed mechanism of the drill press, its timing will be regular enough

* As has been thoroughly tested and practically developed by the Richard Frères, Paris, in their diaphragm (or springless) traction dynamometer.

to allow of integrating the record for the mean effort exerted during the drilling operation.

For the Alden, Prony, Webber, Lewis and other forms of scale-arm absorption or transmission dynamometers, the method of Fig. 13 will be found equally adapted by using a closed system with a pressure-recording gauge.

Fire at Purdue University.

The loss by fire of the mechanical laboratory of Purdue University at Lafayette, which occurred the evening of the 23d inst., is a loss to the profession of mechanical engineering as well as to the university to which it belonged.

Very much of the most advanced and most valuable laboratory work of the time has been done there during the past few years, especially in the matter of tests of locomotives, the apparatus fitted up there for that purpose having been unique and unequaled. Some of the results attained by its use have been given our readers; a letter from Professor Goss on effects of different lengths of connection to indicator having been published only last week.

The building burned was a new one, recently accepted from the contractors and dedicated on the 19th inst. It cost $100,000 and contained paid for equipment to the value of $70,000 aside from that which had been presented to the laboratory. It is understood that immediate steps to rebuild will be taken.

Foreign students of American engineering economy get a wrong impression when it comes to railroad grade crossings in large cities. Permission is constantly being given railroads to multiply such crossings, but this permission is obtained in spite of the protests of engineers, and as to that matter, in spite of the fact that the majority of the citizens know it to be wrong in every way. We doubt if there is a single recent instance of creating a grade crossing in this country in a city of fifty thousand inhabitants that was not a matter of dollars and cents between a railroad corporation and some one with a "pull." It is a libel on the citizens to assert that they do not know better. It might be assumed that the matter would be corrected by the votes of the people, but experience shows this to be something hard to accomplish. The average city voter in this country votes the "straight" ticket without reference to a few people—more or less—killed at grade crossings, and the fellow with a vote to sell to a railroad makes his bargain without any serious consideration as to future political preferment. That is exactly all there is of the matter.

The experiences of cities in all parts of the country with the trolley system are practically the same. Franchises are granted without any very definite restrictions as to speed or other considerations of safety; then, when the killing of people becomes so notorious that some attention must be paid to it, it is found impossible to enforce any material restrictions; the public must be satisfied with the farcical arrest of a motorman occasionally, who is, in due time, released for the sufficient reason that there is no cause for his arrest. If more attention was given to the granting of franchises there would be less trouble afterwards, and less loss of life. The problem of transporting passengers in large cities is a serious one, but the people demand speed, and they get it at the sacrifice of safety.

MANUFACTURES.

The Consolidated Car Heating Co., Albany, N. Y., is running overtime.

There are good prospects for resumption of work at the Western File Works, Beaver Falls, Pa.

The new mill of the Diamond Mills Paper Co., at Millbank, N. J., is being put in place by the Berlin Iron Bridge Co., of East Berlin, Conn.

The blast furnace of the Norton Iron Works, Ashland, Ky., has resumed, giving employment to 600 men. It has been seven years since the entire plant was last in operation.

The Riverside, Belmont and La Belle Iron Companies, Wheeling, W. Va., have notified their employes that the mills will resume work. The three plants employ over 2,000 men.

The Safety Emery Wheel Co., Springfield, O., issue a catalogue of emery and corundum wheels and emery wheel machinery. They are putting a new wheel on the market, which, owing to its construction and mounting, is claimed to be almost absolutely safe against bursting.

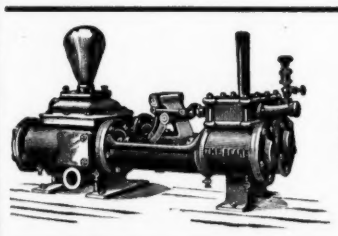
S W. Card & Co., Mansfield, Mass., have issued an 1894 catalogue of taps and dies suited to the various purposes of such tools. The catalogue is a very fine one, and will be likely to be preserved by those who have use for such tools. In addition to complete illustrations of tools, there are several half tone views of exterior and interior of shops.

The Berlin Iron Bridge Co., of East Berlin, Conn., have received the contract for an iron roof for the boiler and engine room of DeLand & Co., at Fairport, N. Y. The roof will be covered with the Berlin Iron Bridge Company's patent anti condensation corrugated iron. This company also has the contract for the iron roof of the new producer house of the Citizens Gas Co., of Brooklyn, N. Y This building is 69x151 feet, the iron roof to be covered with slate.

The statement that the Davis & Farnum Manufacturing Works, of Waltham, were shut down three days the past week is not correct. They have been running every working day for a number of years, and during the last depression were one of the few concerns in Waltham that did not have the working hours reduced or closed for several days. The company, we are informed, employed more help the past year than ever before, and expect to do considerable work the present year.—*Commercial Bulletin.*

About a year ago the Joseph Dixon Crucible Co., of Jersey City, issued a pamphlet on lubricating graphite. It embodied an elaborate scientific opinion by Prof. R. H. Thurston on the value of graphite as a lubricant, and much interesting information on the subject from practical men. The pamphlet has had a large circulation, and the company has been enabled to obtain from well-known men a vast amount of additional knowledge on the uses of graphite. Another pamphlet, twice the size of the former, will be issued early in February, and a copy will be sent free of charge to all interested in the subject of friction and lubrication.

Maris & Beekley (Engineers and General Machinists, Overhead Tracks, Trolleys and Switches, Portable Hoists, etc.), Philadelphia, Pa., write us: At the time we received your valued favor of 9th ult., the entire business condition seemed so completely flat and unpromising to us, that we concluded it would be better not to reply at all, than to send for publication our very gloomy view of affairs, which we felt would not be of use to any one, or even cheering, and which we also felt might prove to be a transient one. In this latter respect we take pleasure now in saying our hopes have been realized rather sooner than we expected, and although the financial situation is still very slow, yet since the first of the year we have received a substantial and constantly increasing number of inquiries, which shows that business men are again thinking of buying. In addition to this, we have actually secured several large orders, as well as some from abroad, which are evidently the result of our World's Fair exhibit. It certainly begins to look to us as if the worst of the recent depression was over, and we feel sure that once the wheels of business get started, they will soon be revolving at a satisfactory speed. Of course, we are aware that the above will be too late for publication, as you intended, but we thought yours of 9th was certainly deserving of a reply, even though a late one.



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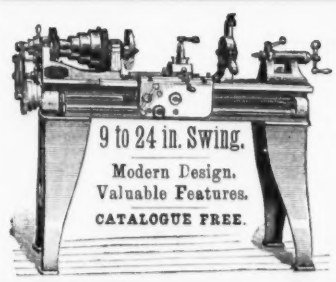

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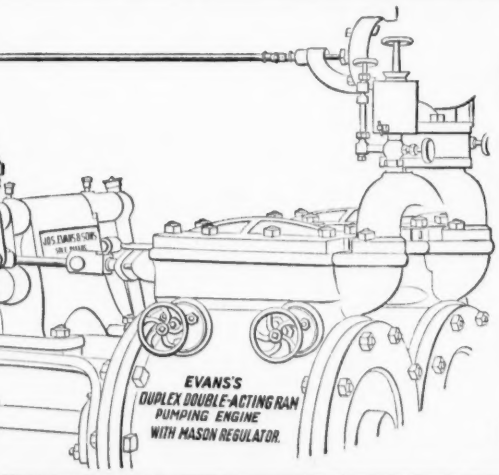

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Machinists' Supplies and Iron.

NEW YORK, January 27, 1894.

Iron—American Pig We quote Standard Northern brands. No 1 Foundry, $13.00 to $14.00: No. 2, $12.50 to $13.25; Gray Forge, $11.75 to $12.50. Southern brands of good quality are obtainable at $13.00 to $14.00 for No. 1 Foundry; $12.00 to $13.00 for No. 2, and $11.25 to $12.00 for Gray Forge.

Antimony—The market is quiet. We quote L. X., 9⅜c. to 9½c.; Cookson's, 10c. to 10½c.; Hallett's 9c. to 9½c., and U. S. French Star, 10c.

Lard Oil—Prime is quoted at 70c. to 71c.

Copper—The market is quiet and steady. We quote Lake Copper at 9.85c. to 10.05c. for spot. Casting Copper is held at 9¼c. to 9.40c.

Lead—The market is quiet and steady at 3.22½c. to 3.25c.

Spelter—The market is dull. Sellers are asking 3.52c. to 3.60c. for New York delivery.

Tin—The market is quiet and lower. Jobbing parcels are moving at 20.05c. to 20.10c. for spot.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Foremanship by one of exp; engines, pumps, or gen. repairing. Indicator, AM. MACH.

Engineer wants pos. as first ass't in some electric light or power station. Engineer, AM. MACH.

Tool maker, exp'd, tools, punches, repairs, gear and rack cutting, wants pos. Tools, AM. MACH.

An exp'd foundry foreman is open to engage't, can give first-class refs. E. L., AM. MACHINIST.

Eng. and draftsman, 33, married, wants change. Boilers, engines, general mach'y. O. C., AM. MACH.

Pattern maker—Sit'n wanted by young man; exp. as foreman, electric & gen'l mach y. E, AM MACH.

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Comp. draftsman exp'd in eng., boilers and general mach. wants position. Box 3, AM. MACHINIST.

Draftsman of six years' experience, wishes position; references. Box 7, AMERICAN MACHINIST.

Machine draftsman of exp., unexcelled skill and ability, is open for engagem't. G. H. R., AM. MACH

Wanted—Foremanship; exp'd in machine tool building; seven years as foreman; age, 31; can do drafting; the West preferred. "Chord," AM. MACH.

Foundry foreman wants position; thor'ly competent, experienced and successful, engine mach'y, valves, chilled rolls, etc. I mix metal from its chemical analysis. Cylinders, AM. MACHINIST.

Mechanical eng. and designer, with experience in marine engines and boilers, high grade Corliss and hoisting engines, is open for engagement; best references. Address T. U 33, AM. MACHINIST.

Situation wanted; 37 years old; have had experience as machinist and tool maker 22 years; had charge of forging dies past six years in locomotive shop. Box 752, AMERICAN MACHINIST.

Wanted—A blacksmith who is familiar with tempering and case hardening by the use of Brown & Sharpe furnace; give age, references and wages expected. Box 5, AMERICAN MACHINIST.

A good all round machinist (one that can do forging preferred) that is temperate and industrious wanted for steady work. Address, stating wages expected. B. B. Beardsley, Waterville, N. Y.

Asst foreman boiler maker, locomotive works, age 35, thorough mech., make estimates, wants pos. as foreman, or contract to build or rebuild boilers, tanks, reset tubes, etc.; R. R. shop pref'd; refs. A1. "Temperate," AMERICAN MACHINIST.

Wanted—Machinist, competent to manage either the shops or office business of a machine shop and foundry, well equipped and well located; one who can put in a small working capital preferred; company chartered. P. O. Box 463, Dalton, Ga.

Wanted—Situation as foreman or superintendent of machine shops; have held both positions; experienced on Corliss engines, mining & gen. mach'y; 38 years of age; 22 years' practical experience; first-class references. Address Box 4, AM. MACHINIST.

Wanted—First-class machinist, who has had practical experience in designing and making tools for a milled machine screw factory; rising young man preferred; must be temperate, reliable, and well recommended; state salary, experience, age, etc., John Morrow Machine Screw Co., Ingersoll, Ont., Canada.

A mechanical engineer, 36 years, experienced in the design and construction of high grade engines, special tools, and general machinery, competent in handling men and work systematically, desires position as superintendent of works or chief of engineering department; and is open for immediate engagement. Address Competent, AMERICAN MACHINIST.

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(*Continued on page* 14.)

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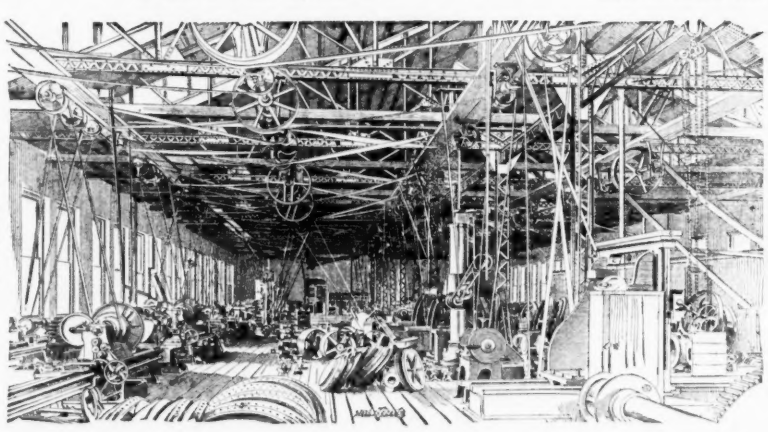

Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the interior of a Machine Shop, the Roof of which was designed and built by us for the Titusville Iron Co., at Titusville, Penn. The building is 70 feet in width by 205 feet in length. The roof trusses are made entirely of iron, and designed to carry shafting. Through the centre of the building is a row of wrought iron columns. Machine shop roofs built after this plan are not only much neater in appearance than heavy, cumbersome, wooden trusses, but are stronger and stiffer; and where no wood is used about the construction the danger from fire is entirely eliminated.

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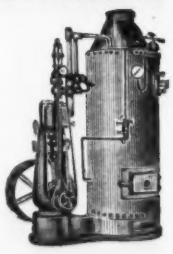

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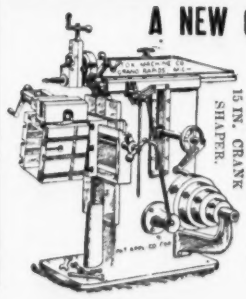

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Length of stroke changed INSTANTANEOUSLY while IN MOTION.
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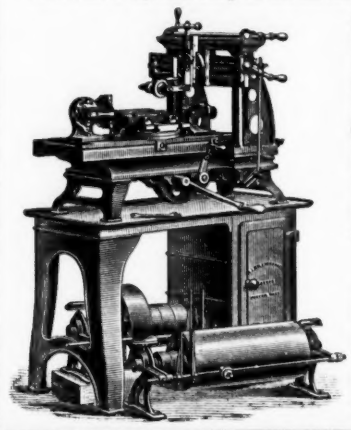
Has all the Improved Features Usually Found on High Grade Planers, and is Capable of Doing the Best and Finest Work.



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With Steel Screws, Lathe Made and Hardened.
This Dog has a Very Heavy Base so that if the thread wears a Heavier Screw can be substituted.

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9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.30
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
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Full set of 19		$21.60
20 (ext.)	5 1-2	4.00
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When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.
One Small Set of 8—by 1-4 inches to 20 inch, - - $6.25
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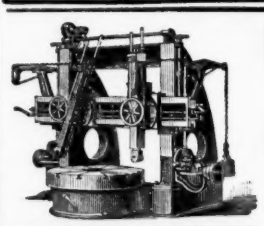

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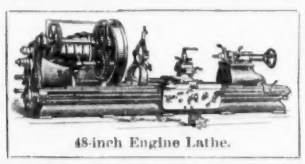

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Wanted—Thoroughly practical draftsman on the Corliss engine. Address stating age, experience, and salary required, BOX 6, AMERICAN MACHINIST.

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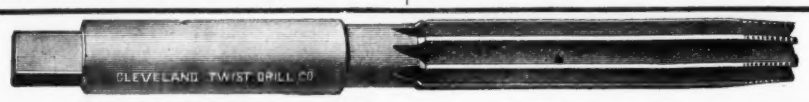
We will pay 50 cents each for copies of the AMERICAN MACHINIST of December 4, 1886 issue; must be unsoiled and in good condition. AMERICAN MACHINIST PUBLISHING COMPANY, 203 Broadway, New York.



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Improved 15 in. " " " "
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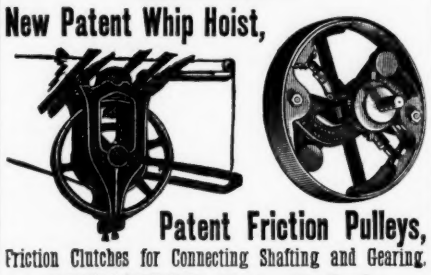

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Boiler Shop Outfit, Bement, Miles & Co. make.
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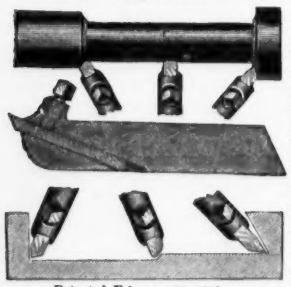

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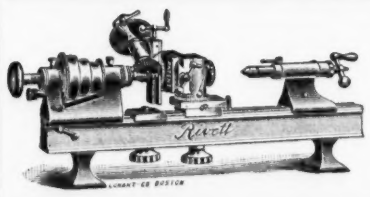

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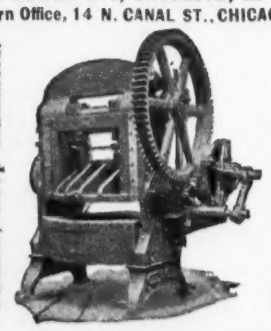

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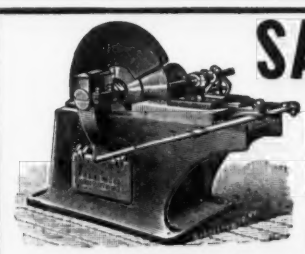

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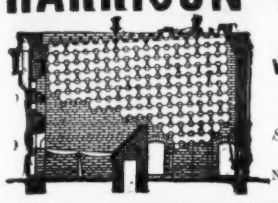

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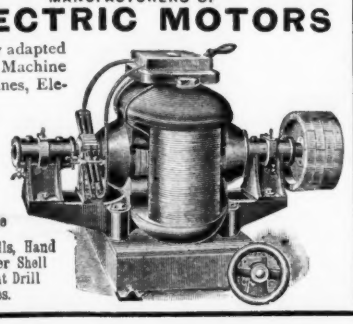

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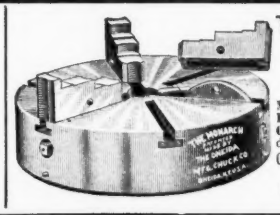

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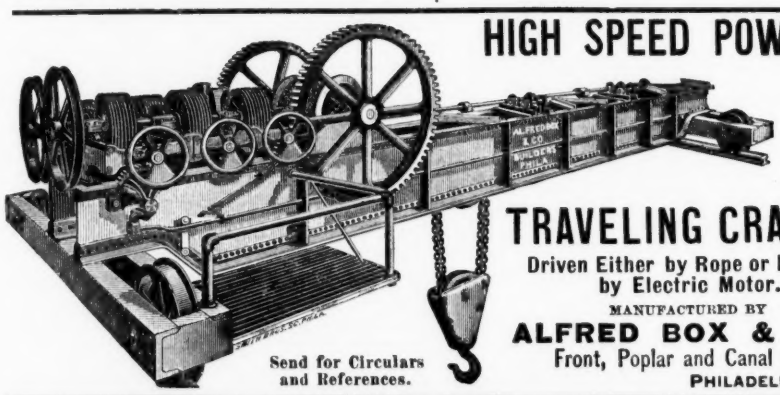

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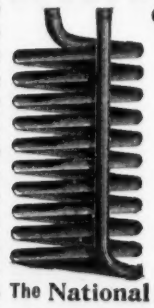

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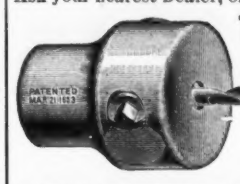

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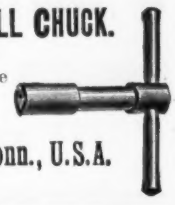

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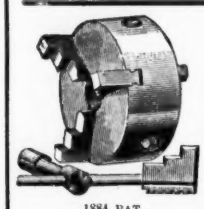

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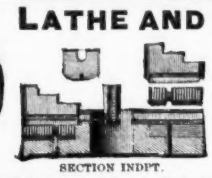

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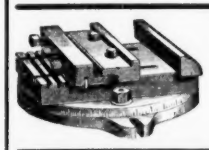

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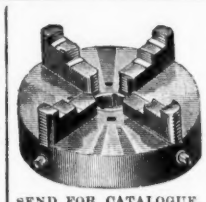

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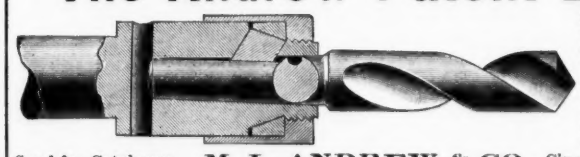

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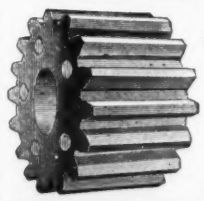

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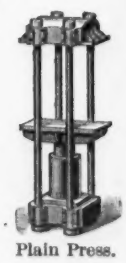

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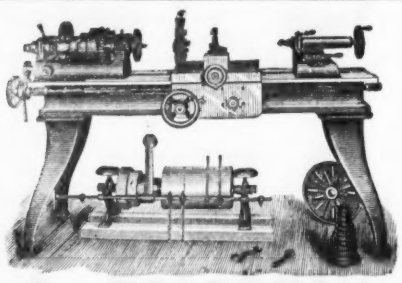

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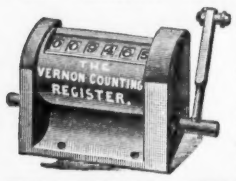

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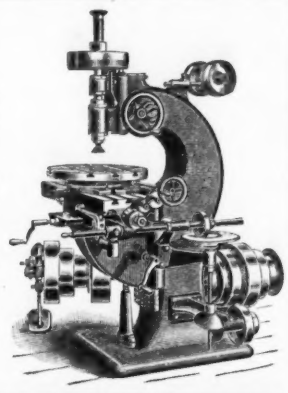

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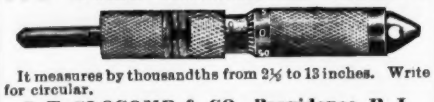

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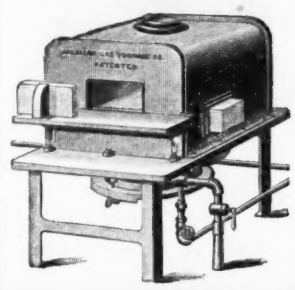

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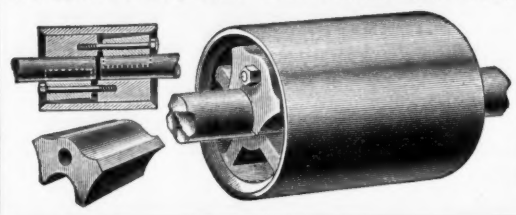

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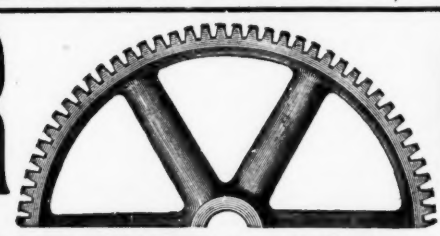

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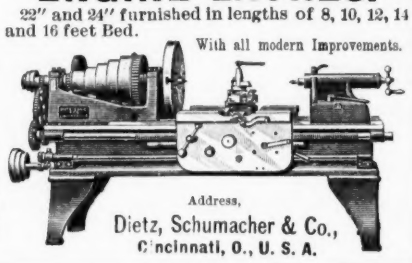

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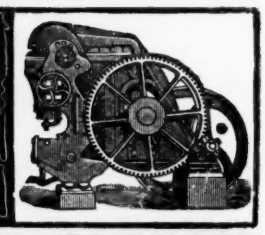

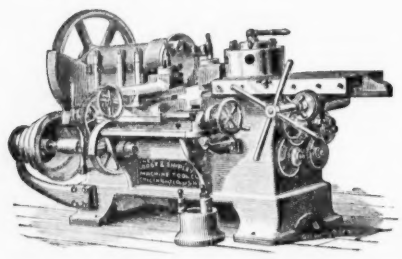

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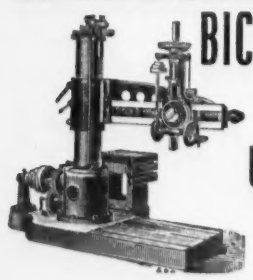

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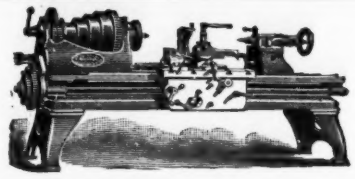

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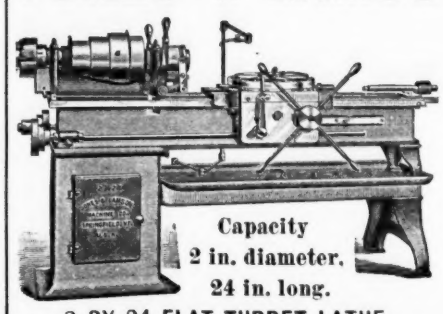

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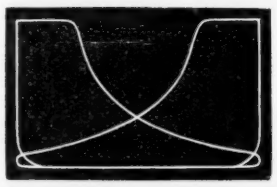

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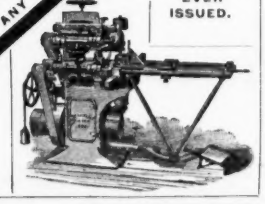

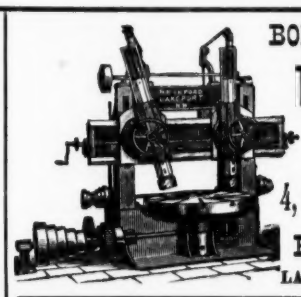

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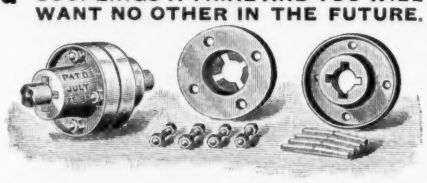

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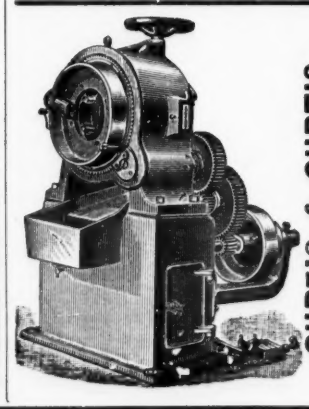

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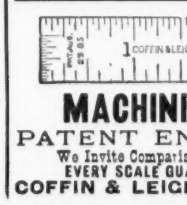

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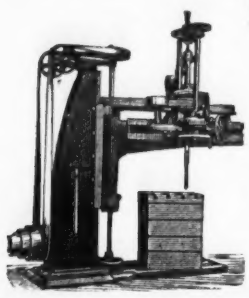

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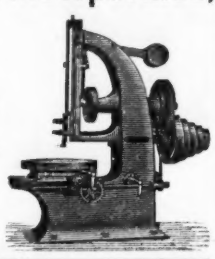

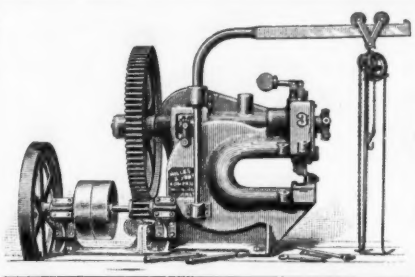

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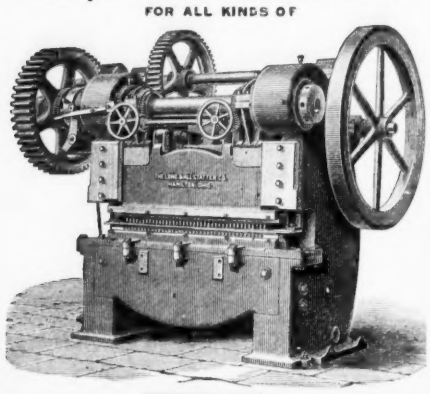

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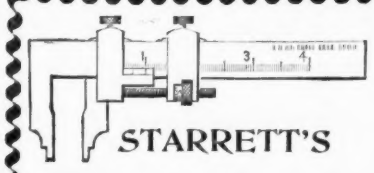

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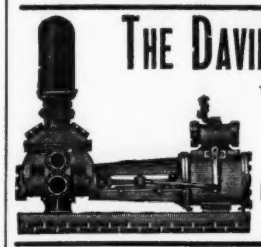

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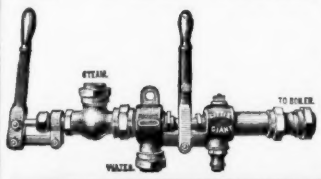

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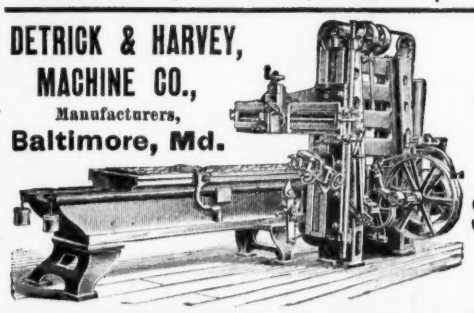

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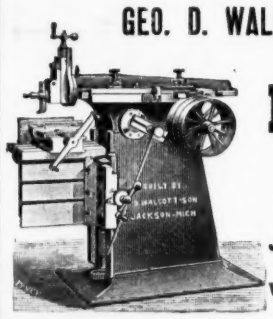

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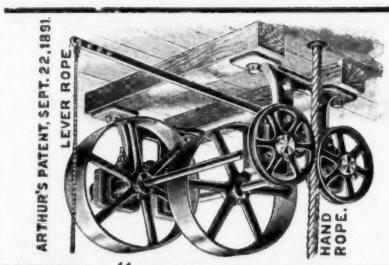

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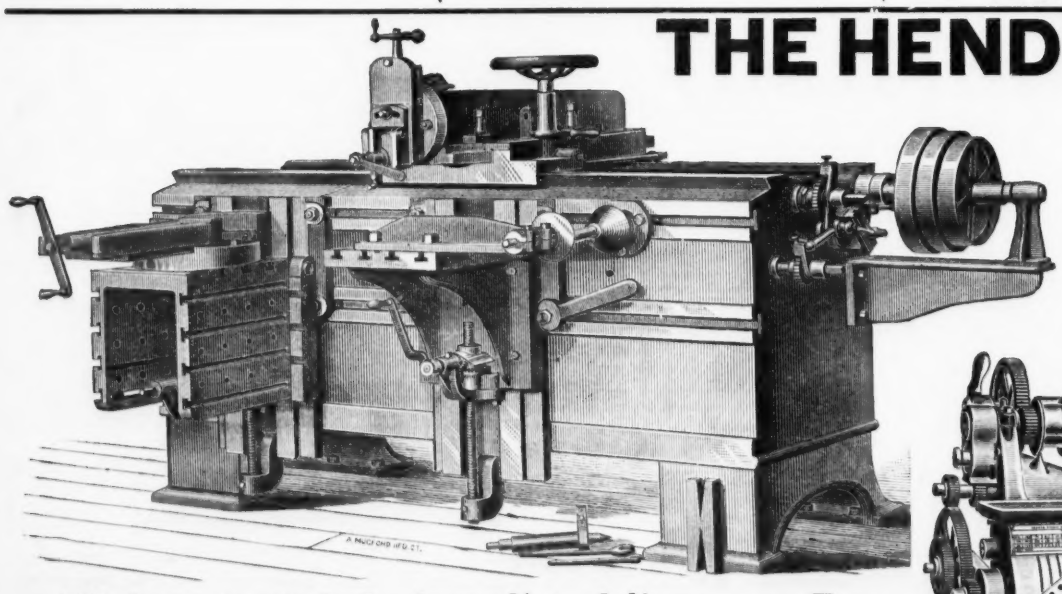

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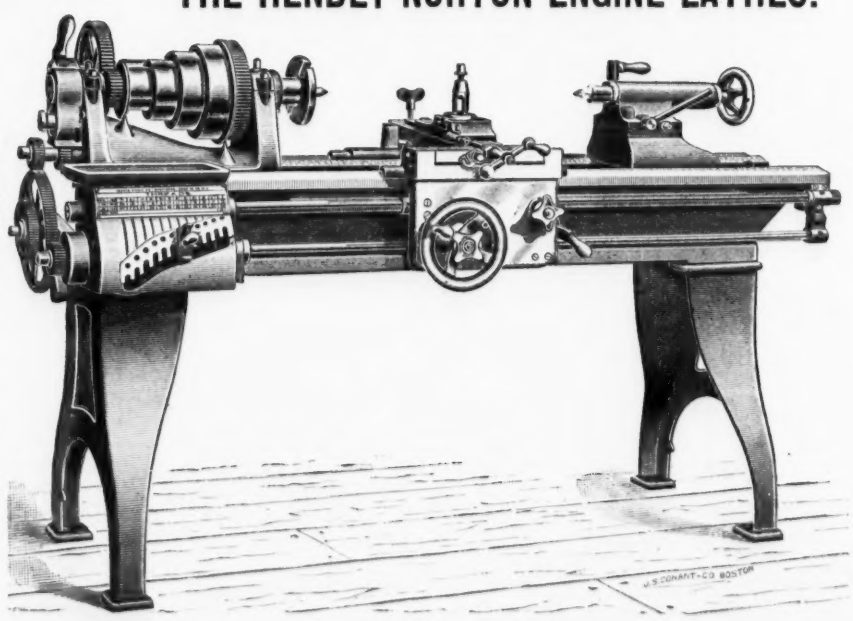

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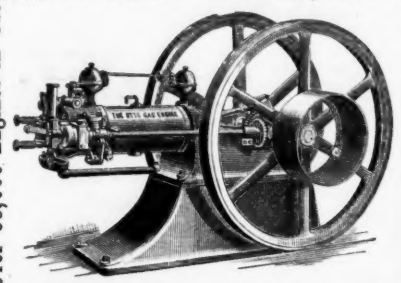

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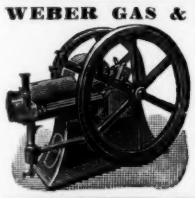

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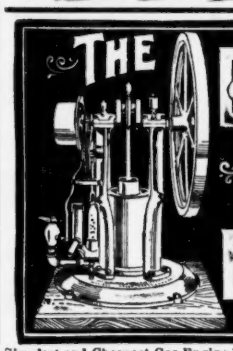

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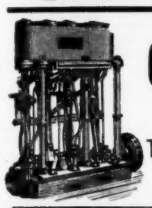

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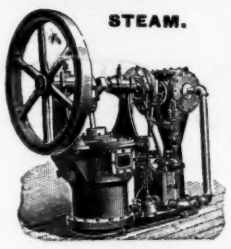

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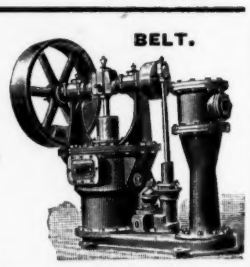

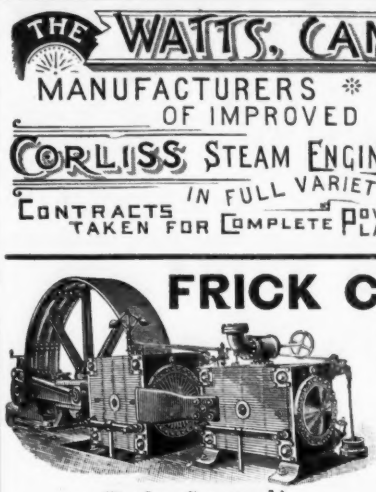

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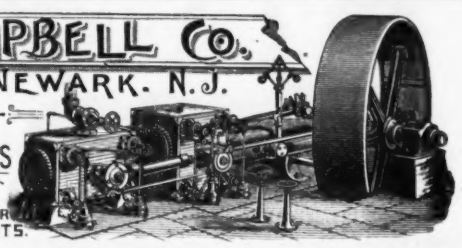

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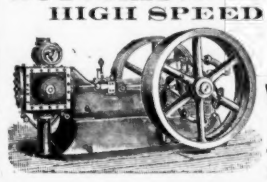

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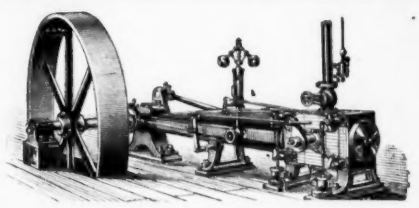

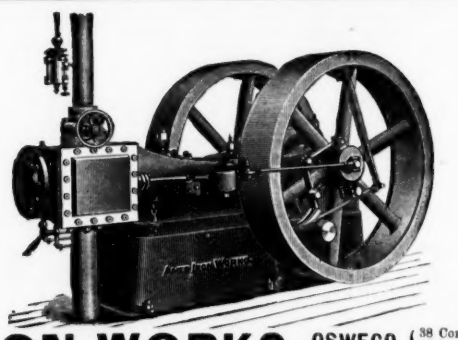

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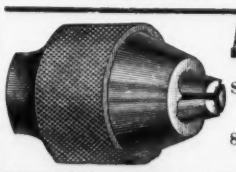

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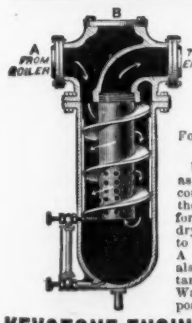

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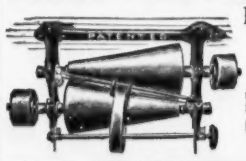

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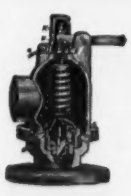

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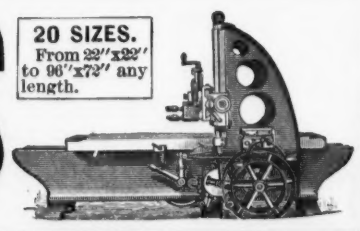

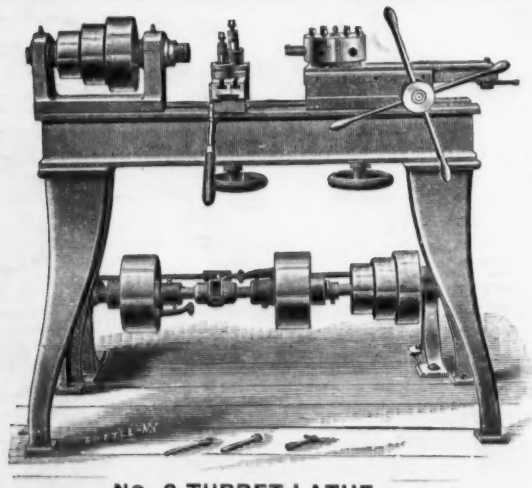

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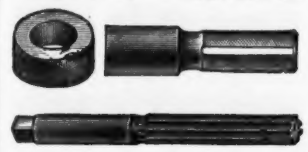

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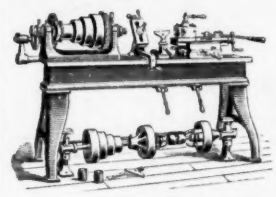

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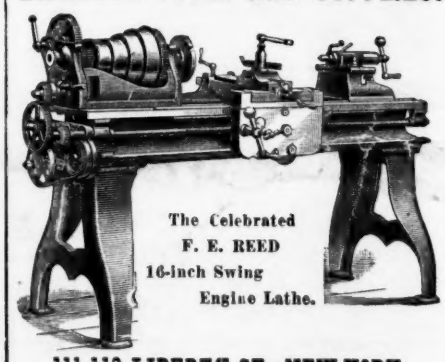

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